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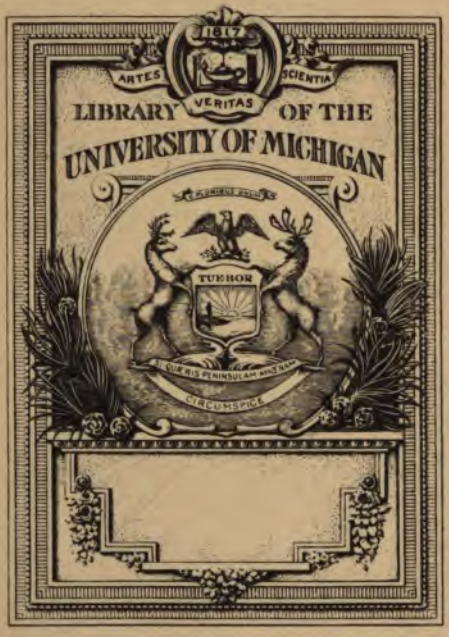
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THE TEACHER'S GUIDE

TO ACCOMPANY THE TEXT-BOOK OF

ELEMENTARY PHYSICAL GEOGRAPHY

BY

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PREFACE

THE following pages are in effect a summary and extension of an active correspondence with teachers that has grown up since the publication of the author's "Physical Geography" and "Elementary Physical Geography." The progress made in this branch of earth science during recent years has been so rapid that any text-book in which the modern aspects of the science are presented must awaken many questions in the teacher's mind. It is with the desire to answer these questions that the following suggestions and explanations have been written out. A number of laboratory exercises are here outlined; but a much larger number will be described in a handbook by the author, "Practical Exercises in Physical Geography," soon to be issued.

References to the author's text-books are indicated by the abbreviations EPG and PG, with page or section number. When no abbreviation is used, EPG is understood. The detailed suggestions by chapters follow the order of the more elementary book, but are equally applicable to the corresponding topics of the second.

W. M. D.

CAMBRIDGE, MASS.,
March, 1903.

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CONTENTS

	PAGE
The Nature of Geography	1
The Preparation of the Teacher	2
Reading and the School Library	3
The School Equipment	10
The Recitation Room	11
The Lecture Room	12
Practical Exercises	13
Pictures	16
Diagrams	16
Maps	18
Globes and Models	25
Excursions	27
Notes on Chapter I. The Earth as a Globe	33
" " " II. The Atmosphere	36
" " " III. The Ocean	45
" " " IV. The Lands	54
" " " V. Plains and Plateaus	57
" " " VI. Mountains	60
" " " VII. Volcanoes	64
" " " VIII. Rivers and Valleys	66
" " " IX. Deserts and Glaciers	73
" " " X. Shore Lines	76
" " " XI. The Distribution of Plants, Animals, and Man	78

THE TEACHER'S GUIDE

THE NATURE OF GEOGRAPHY

Geography deals with the relations between the earth and its inhabitants, and especially between the earth and man. It is a broad subject, involving an understanding of the various physical features of the earth, on the one hand, and an acquaintance with the many conditions of organic life, especially of human life, on the other. Geography therefore consists of two parts: one deals with the physical environment of living forms; the other with the response made by living forms to their environment. It is the first of these two parts, known as Physical Geography or Physiography, that we have here to consider; but it is important that, in this study of the physical or inorganic features of the earth, it should be remembered that they are of interest to the geographer largely because they constitute the environment in which the living objects of his study spend their lives.

Geography as taught in the schools deals broadly with the simpler, leading facts and principles of earth science, selected from the vast body of information that makes up our knowledge of the subject as a whole. Elementary Physical Geography, as a part of Geography, includes a comprehensive view of the simpler features of the earth viewed as the home of man. Yet even when thus limited, Physical Geography must include a consideration of many

diverse problems, because the physical environment of life includes so many unlike factors, ranging from the earth as a globe, through the atmosphere and the oceans to the lands. The necessary diversity of the different parts of the subject is at once an advantage and an embarrassment; an advantage because in so broad a range of study the great variety of interesting phenomena encountered is attractive to the student; an embarrassment because the familiar acquaintance that is demanded with so great a variety of phenomena is a serious responsibility to the teacher. The importance of the subject is, however, so great that the labor of preparing to teach it is well bestowed; and there are few, if any, subjects in which the labor of preparation is so richly repaid by a responsive interest on the part of the pupil.

THE PREPARATION OF THE TEACHER

Like any other subject that deserves its place in the schools, Physical Geography should wherever possible be taught by a well-prepared teacher, who is at ease in the recitation room, the laboratory, and the field. The beginning of good preparation is a good school course, to be followed by further study with plenty of practical exercises and excursions in the normal school or the college. Upon this foundation the young teacher should continue to build by abundant reading of good sources (see suggestions for Reading), by taking advantage of every opportunity for field observation (see Excursions), and by attending when possible a summer session of some college or university where a new aspect of the broad subject may be learned. Much aid can be had from local teachers' clubs and scientific societies; but it should be more generally understood that those who speak in meetings of these kinds learn more than those

who listen — the preparation for speaking is in a high degree educative and profitable.

With every year's repetition of the school course there should be improvement in every phase of teaching: more effective amplification of the text, new examples quoted from reading, new pictures and maps for illustration, new devices for practical exercises, new paths for excursions. All this means work, unceasing work; but work is made easy by enthusiasm and delightful by success. Let the teacher therefore persevere until the phenomena of the turning earth and the changing seasons are his familiar companions through the year; until the winds and the weather proclaim to him the great system of movements in the atmosphere of which they are but parts; until the waves, the currents, and the tides swing freely through the ocean of his imagination; and until the hills and streams commune with him as he walks by them.

READING AND THE SCHOOL LIBRARY

The References for Supplementary Reading given in the text-book (EPG, 377–385), reënforced by those given below, will not only lead to many suggestive essays, they will also lead to many other articles not cited in the text. The teacher who makes good use of these references will become familiar with many sources of information, and his knowledge of geography will be thereby greatly broadened and strengthened. The pupil who reads even only a few of the articles referred to will learn that Geography is a larger subject than can be included in a single text-book. Special suggestions as to pupils' reading are given below.

With the present rapid increase in the number of good public libraries, the teacher's opportunity for consulting

reference books is greatly extended. If the books desired are not found in such libraries, requests for their purchase will doubtless receive due consideration by the librarians. One can thus in the course of a few years usually gain access to some of the geographical journals, a good number of the publications of the United States Geological Survey, and to all the standard general works. For the school library the *Journal of Geography* (the continuation of the *Journal of School Geography* and the *Bulletin of the American Bureau of Geography*) is of prime value. See also the list of books for school libraries by M. I. Platt, *Journal of School Geography*, II, 1898, 181.

So much excellent physiographic material is to be found in the publications of the United States Geological Survey, now so generally available in libraries, that mention is often made of them in the References for Reading; most important are the annual reports, the monographs, and the bulletins (for maps and folios see below, under Maps). These volumes can often be obtained through a senator or representative in Congress. The Survey publications contain much material of a strictly geological nature, and hence some knowledge of Geology will aid the teacher in reading them; but it should not be forgotten that the present object in such reading is the selection of purely physiographic matter. For example, in Russell's account of the great lava plains in Washington, of the mountains isolated by them, and of the canyons eroded in them (Water-Supply and Irrigation Papers, No. 4, United States Geological Survey), the important points to note concern the general quality of the landscape, the relations of the isolated mountains to the main mountain ranges, and the special features of the canyons; while the geological structure of the mountains and the petrographical character of the lavas need not be quoted.

It will be found, when judicious selection of physiographic matter is thus made, that the pupils will not be the least embarrassed by the to-them-unknown fact that the information came from a geological source. It would, on the other hand, be manifestly unwise to expand the brief statement of the lava plains in the text (EPG, 228, 229) by saying that the isolated mountains are made of quartzite and quartz-schist, and that the lavas are basalts and hypersthene-andesites. Examples of more appropriate extracts from this essay are given below.

Well-trained habits in taking notes on reading are of great service. Reading is thereby made much more accurate and serviceable. The following suggestions have been tested and found effective. Reading may be with various objects, of which two are here considered: one object is to find examples of different kinds of physiographic things, such as land and sea breezes, ocean currents, embayed mountains, oxbow lakes, hanging valleys, and so on, wherever they may occur; the other object is to learn all the kinds of physiographic things that occur in a certain area, as in Minnesota or in Japan. The first object may be called systematic; the second, regional. It is with the first that we are here chiefly concerned. For notes on systematic reading as thus defined it is essential to adopt a classification of the whole content of the subject studied; for this purpose the table of contents, paragraph headings, and technical terms of the text-book in use may be taken as a working scheme of classification, with respect to which the notes from articles read may be conveniently arranged. Then when reading any article make brief notes of the best examples of the various kinds of physiographic items there found, or of the organic responses to these items according to the classification adopted. Articles or

items that seem fitted for pupils' reading should be so recorded.

The notes should be taken on light cards large enough to contain one hundred or more written words; long notes may fill two or more cards. Each card should be headed with the name of the kind of item there noted, and reference to the author and source of the note should always be appended. Cross references from one card to another are serviceable. If the author's exact words are copied, inclose them in quotation marks; if any words are omitted from a quotation, indicate the omission by a few dots; if any words are added, inclose them in square brackets — [ ]; if only an abstract is recorded, do not use quotation marks. Minutely careful habits of this kind give a sense of security that will be found most helpful. The note cards should be arranged in a box according to the scheme of classification adopted. A similar method may be followed with regional reading, in case the teacher has a class in general or regional geography. The following specific illustrations may be serviceable:

Lava Plains, Washington, U.S. — Consist of a series of horizontal lava sheets, 50′ to 100′ each; 2000′ to 3000′ total. Older mountains of crystalline rocks are buried under lava. Spurs of bordering mountains project into the plain (plateau), "like headlands along the ocean shore." "The lavas entered the valleys and gave them level floors of rock." Some mountains were completely surrounded by lava, "and now rise as islands above its surface." Steptoe butte is one of these islands, 10 or 12 m. from shore; 1000′ over plain; steep slopes, prominent landmark, hotel on top. View from summit recalls ocean in limitless expanse to N., W., and SW. The topography is young. The larger rivers have cut deep canyons (see Canyons, Snake River); but in general "the streams have not advanced far in their task of cutting away the rocks forming the plateau and of reducing the land to sea level,"

because of an inferred decrease of rainfall. "Standing on the plateau between the branches of the various streams that have sunk their valleys deeply into the rocks, the valleys, canyons, and ravines are concealed from view, and a limitless plain extends away to the horizon in all directions, or to the bordering mountains." Lava surface is weathered to fine soil mantle. "Not a pebble is to be seen." Fine view of great wheat fields in Plate II. (Russell, "Water Supply and Irrigation Papers," No. 4, *United States Geological Survey*, 1897.)

Canyons, Snake River, Washington. — In SE. corner of state, canyon 4000′ deep, but farther west 2000′, nearly all in lava beds (see Lava Plains). Canyon walls are benched by unequal weathering and recession of different lava beds; range horses pasture on benches. Walls scoured by steep lateral gulches with buttresslike ridges (spurs) between them. Larger tributaries have curved and branching lateral canyons, 10 m. long or more. The main river is still deepening canyon; has numerous bed-rock rapids; few and narrow flood plains in curved strips at bends. These strips, irrigated, yield fine fruit crops, for which the warm climate of the canyon bottom is especially favorable. Close to SE. corner of state, erosion of canyon has revealed a buried mountain of the foundation crystalline rocks; it is shown in section a mile long, 2000′ (?) high, with 1000′ of lava beds above it to plateau level. Older rocks resist weathering better than lava beds, and canyon is here narrower, with precipitous walls, not benched. Farther up canyon, another buried mountain, 2500′ high, with 1500 lava beds above it. In no case does canyon show bottom of ancient valleys between the buried mountains. (Russell, "Water Supply and Irrigation Papers," No. 4, *United States Geological Survey*, 1897.)

In order to make notes practically useful, marks should be made on the margin of the text-book pages, opposite the account of the topics to which the various notes refer; then in preparing for a certain lesson the teacher can

easily take from the note box all the cards containing notes on the topics to be considered: it is chiefly for this reason that the systematic arrangement of the cards is better than the alphabetical. If only three or four articles are read and carefully noted each month, a valuable collection of note cards will soon be formed. Careful reading and abstracting make laborious but extremely profitable work; if continued for a few years the teacher will be well repaid by the fund of valuable and available information thus gathered. A considerable number of "Current Notes on Physiography" by the author may be found in most of the volumes of *Science* (new series) since 1895. There can be no question that a teacher who can bring forward from the background of his knowledge pertinent illustrations, such as good notes furnish, will feel at ease in his work.

The chief problem with regard to reading for pupils is to find articles that are at once sufficiently elementary in style and serious in object. The disciplinary value of systematic Physical Geography is not likely to be increased either by the pupil's study of elaborate geological reports written in a mature and technical style, or by his reading stories of travel by authors who have little acquaintance with the modern aspects of our science. There is really a dearth of good physiographic reading prepared by experienced investigators for young students. Nearly all the books and articles in the Appendix were written for mature readers; hence when immature readers are referred to them it is well to make the reference specific as to topic and page, and to indicate very closely what kind of items should be made note of in a written report. The reading is otherwise apt to be desultory, if indeed the pupil is not discouraged by finding too much that he cannot understand.

The most important topics for pupils' reading are such as bear directly upon the text. The articles in the list of references were written for various other objects than the illustration of a text-book, and hence contain various matters irrelevant to the pupil's needs. The teacher should therefore be sufficiently familiar with the articles to give the pupil definite guidance by topic and page to what will be most serviceable; and the books that prove most serviceable should be secured for the school library where they can be most readily accessible. The pupil should be expected to make some report, oral or written, and preferably written, on his assigned reading. He should be encouraged to read as much more than his assignment as he chooses.

The following references may be taken as a supplement to the lists in the text-books (EPG, 377; PG, 409):

Journal of Geography. Rand, McNally & Co., Chicago. This is especially devoted to the needs of teachers. It is the successor of the Journal of School Geography and the Bulletin of the American Bureau of Geography.

Text-books of Physical Geography by GILBERT and BRIGHAM (Appleton), TARR (Macmillan), or DRYER (American Book Co.), will be found useful for "parallel treatment."

Text-books of Geology by BRIGHAM (Appleton), TARR (Macmillan), SCOTT (Macmillan), DANA (American Book Co.), LECONTE (Appleton), or GEIKIE (Macmillan) will be serviceable for reference. DANA'S Manual of Geology (4th ed.) and GEIKIE'S Text-Book of Geology give an elaborate treatment of the science; DANA'S Text-Book (revised edition by Rice) and GEIKIE'S Class-Book of Geology are more elementary.

J. GEIKIE, Earth Sculpture. Putnams, 1898.

A. GEIKIE, The Teaching of Geography. Macmillan, 1892.

HERBERTSON, Descriptive Geography from Original Sources. Extracts from many authors. Separate volumes for the several continents. Black, London, 1901.

Physical Geography of the United States (American Book Co.). The volume of essays first published as the National Geographic Monographs (EPG, 378) is now issued under the above title.

TARR, Physical Geography of New York State. Macmillan, 1902.

DRYER, Studies in Indiana Geography. Inland Publishing Co., Terre Haute, Ind., 1897.

LORD AVEBURY (Sir John Lubbock), Scenery of England. Macmillan, 1902.

THE SCHOOL EQUIPMENT

It is seldom possible to secure the complete equipment for instruction in Physical Geography all at once; but if something is added every year, the equipment will soon reach an effective strength. Some practical suggestions will be found in an article by the present writer, on "The Equipment of a Geographical Laboratory" (*Journal of School Geography*, II, 1898, 170–181), in which the arrangement of teacher's desk, scholars' seats, cases, working tables, and map racks in a single room is planned so as to secure good light, compact and convenient storage of material when not in use, small distance of carriage to where the material is used, and so on. Better arrangement can be made in certain respects if a lecture room with lantern and screen and a laboratory for practical exercises are provided in addition to the recitation room, but care should be taken to avoid any plan that involves the frequent carrying of illustrative materials from one room to another; the

labor thus caused will inevitably tend to decrease the use of the materials. Specific suggestions under the several following headings may be found useful.

THE RECITATION ROOM

The room in which recitations are held should when possible be provided with a globe, physical wall maps of the continents (preferably mounted on spring rollers), wall blackboards for the teacher's illustrations and for the pupils' exercises, and light racks for diagrams hanging by halyards from the ceiling (the upper edge of the rack strips should be rabbeted to less than a quarter-inch thickness, so that diagrams can be hung there with spring clothespins or with S-hooks). An outline Mercator map of the world, painted on a blackboard (with equator across *middle* of board), and an outline map of the United States on another board are very serviceable for many problems of distribution; to save space, these blackboards can be framed so as to slide up and down against the wall, one in front of the other. Maps of special districts, for use in illustrating the text, should, if more than two feet square, be backed with light cotton cloth and mounted on sticks, top and bottom; they should be kept rolled up, on brackets, in a covered case; when in use, small brass rings, fastened by tape to the upper stick, may be caught on S-hooks on the hanging racks. Large diagrams may be similarly treated. Small diagrams and map sheets are best kept flat on narrow-spaced shelves; they are easily attached to the racks by spring clothespins. A case for the most important reference books should stand near the teacher's desk, accessible to the pupils. The wall maps of the continents should be used in defining the location of examples mentioned in

the text, and in preparation for this the pupil should become familiar with the localities by learning them on the maps, Plates A to I, at the end of the text-book. When the teacher introduces a new illustration, its position should be similarly indicated.

THE LECTURE ROOM

The room in which illustrated lectures are given needs a lantern, a screen, and dark window shades or shutters, in addition to its usual furniture. The collection of lantern slides is most conveniently kept in the room usually occupied by the teacher. Various dealers in slides now advertise collections for illustration of Physiography.[1] Care should be taken to get lantern slides that really illustrate the topics studied in the text. Irrelevant pictures, however beautiful, weaken the disciplinary and educational side of the work. A small set of slides was prepared by the author several years ago, from the Gardner collection of photographs in Harvard University, for the use of the public schools of Cambridge, Mass., and an explanatory list of the slides was printed in the report of the Cambridge School Committee for 1893. The slides corresponding to this list (or with a few changes from it) may be had of E. E. Howell, 612 17th Street, N.W., Washington, D.C. A large number of slides, prepared in connection with the American Bureau of Geography, may be had of E. R. Shepard, Minneapolis, Minn.

There is some advantage in having the lantern installed in the room used for recitation; it may then be frequently

[1] McAllister, Nassau Street, New York; Thompson, Bromfield Street, Boston; Williams, Brown & Earle, Chestnut Street, Philadelphia; Detroit Photographic Co., Detroit; and McIntosh Stereopticon Co., Randolph Street, Chicago, publish catalogues of lantern slides.

used to show a few pictures at the end of a period. There is danger that the lantern will not be used enough if it is in a large lecture room, where special arrangements must be made for its use.

PRACTICAL EXERCISES

A number of suggestions concerning practical exercises may be found in the elementary text-book. Many others will be found in the notes on the successive chapters of the text-book, below. A small handbook entitled "Practical Exercises in Physical Geography" is in preparation by the author.

It may be here said in general that exercises in Physiography which involve mere copying should be replaced by others which demand some change from the original, whereby the pupil's understanding of the problem in hand and his capacity to treat it in a new manner shall be thoroughly practiced and tested. For example, a hachure map may be drawn from a perspective view of a coastal plain (EPG, Fig. 64), or from a block diagram of a valley (EPG, Fig. 130). It is also desirable that the essential features of such maps should be briefly stated in carefully chosen words, as a part of each exercise. On the other hand, when the types of systematic physiography are illustrated by examples chosen from regional physiography, the copying of maps and diagrams that represent actual forms and their distribution is a very desirable aid in learning specific facts; but in this case the exercise should include the memorizing as well as the copying of the originals, so that their essential features (without too much detail) may be reproduced at any time by the pupil; in other words, the serious study of regional physiography should

result in a memory of the graphic representation as well as of the verbal description of its characteristic forms.

Especial care should be taken to see that laboratory exercises do not degenerate into mere manual performance without mental gain. For this purpose a series of questions, written on the blackboard and calling for specific answers, may be of much service in turning the attention of the pupils from the paper on which an exercise is performed to the thing which the exercise represents. It is also important to restrict laboratory work to such exercises as shall give a better understanding of the problems in hand than can be had in any other available way. Mere "busy work" is to be deplored; all the more when it takes time that might be profitably employed on problems that make for intelligence and power. It is very desirable that the amount of purely manual work should be reduced to as small a measure as possible. For example, in drawing isothermal or isobaric charts it would be a great advantage if the pupils were furnished with charts on which the readings of temperature or pressure were already entered (see EPG, Fig. 11), so that the practical exercise should be immediately directed to the problem in discussion, and the time allotted to the exercise should be most economically and effectively used. Some further suggestions regarding laboratory exercises may be found in the following articles:

R. H. Cornish, Laboratory Work in Elementary Physiography. Journal of School Geography, I, 1897, 172, 204.

W. H. Snyder, Laboratory Work in Worcester Academy. Journal of School Geography, III, 1899, 368.

Records of practical exercises (and of field excursions in some cases) are now demanded, with a certificate from the teacher as to their systematic performance, as part of the entrance requirement in Physical Geography of a number

of colleges. It is desirable that the standards of thoroughness and neatness here set should be held for all pupils, whether they are preparing for college or not.

The room in which practical exercises are done should have well-lighted, good-sized tables, where diagrams, maps, and models can be placed for study. Racks suspended by halyards over the middle line of the tables may be used to hold maps, pictures, and diagrams that are too large to lie on the tables. Some of the laboratory material should be prepared in sets of as many pieces as there are pupils in the class (or section) which uses the laboratory at one time (see Maps, below). In order to prevent injury to maps, etc., it is an aid to have hinged frames, glazed on one side, in which the maps can be placed; the frames can then be laid on the tables, and the maps copied through the glass. In exercises on topographical maps it is often an advantage to cut out from the map sheet such part as illustrates the problem in hand, and to paste it on a card. The attention of the pupil is thus held closely to his work, and cards of moderate size are more easily handled and last longer than map sheets. A single map may afford material for several pupils; and now that the maps of the United States Geological Survey may be had for so very low a price (two cents a sheet, if bought by the hundred), the cost of a type diagram may be much less than a cent. All laboratory material should be conveniently stored, near its place of use.

The capacity to draw outline maps from verbal descriptions may be cultivated to advantage. For example, after practice has been given in drawing maps from figures in the text, as suggested above, useful exercises may be stated as follows: Draw a map of a water gap in a ridge trending east and west (EPG, Sec. 158); of an incised meandering valley with a cut-off spur east of its river (EPG, Sec. 157).

PICTURES

A lantern slide, after having been shown to a class for only a few moments in a lecture, may be exposed for more careful study by hanging it against a window pane. If dark external objects near the window cut off the light, a sheet of white tissue paper may be placed between the pane and the slide.

Pictures and photographs from various sources form useful aids, provided they are carefully selected so as really to illustrate the topics of the text. As with lantern slides, it is important to specify as definitely as possible the elements of the picture that should be studied and noted. It is well to ask what paragraphs in the text are illustrated by the different parts of a picture. Useful lessons can in this way be based on figures and plates in the text-book by asking what sentences of Sec. 117 are illustrated in Fig. 92; or what sentences of Secs. 114, 115, 141, 202, in Plate VII; or what sentences of Secs. 180, 181, in Plate XVI. The more definitely the use of a picture is indicated, and the more clearly the work expected of the pupil is specified, the more useful the part played by the picture in his education.

DIAGRAMS

Excellent diagrams for small classes may be made by using a broad-nibbed pen and colored inks (not too dark) directly on the daily weather maps. It is well at first to strengthen one element at a time, *e.g.*, isotherms, winds, etc.; then to show the combination of several elements; then the eastward progress of weather elements in a series of successive maps. The addition of lines of decrease or increase of pressure to a map of isobars (EPG, Sec. 65)

will be found serviceable in the explanation of the winds. Distribution of different weather elements can be shown by dots or cross lines in different colors.

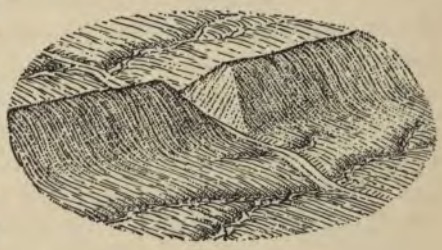

FIG. 1. A Water Gap

In the illustration of typical land forms, the simple profile is hardly sufficient; it leaves too much to the untrained imagination, and is therefore likely to result in vagueness of ideas. The simple map is deficient in pictorial effect; much practice is needed before its conventional lines can be easily and accurately translated into relief. A perspective or bird's-eye view is

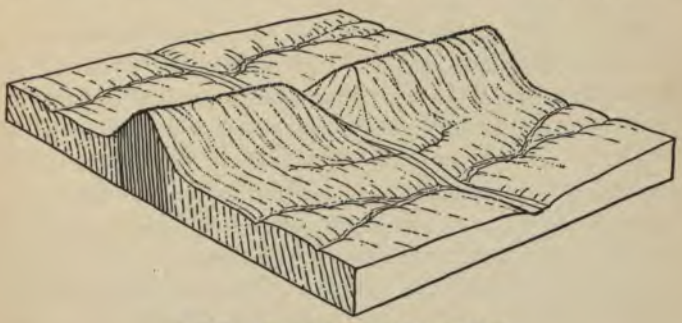

FIG. 2. Block Diagram of a Water Gap

in many respects better than a profile, especially for beginners. Even so rough a view as Fig. 1 serves at first better than a map to show what is meant by a water gap. But the value of the view is greatly increased if it is treated as a block, Fig. 2, for form can then be shown to be dependent

on structure, as in the Pennsylvania ridges (EPG, Sec. 124). Teachers are urged to use such block diagrams whenever possible. One of their values is found in the aid that they give in teaching the pupil what is meant by a vertical section, such as is shown along the side of the block; the pupil thus gains exercise in using his imagination to connect underground structure and surface form. This is important in connection with such topics as cuestas, artesian wells, etc. (EPG, Figs. 68, 120). When practice on the blackboard or otherwise has developed a diagram in satisfactory form, the teacher may save much time in the future by copying the diagram at once in permanent form on rather stout, light-colored wrapping paper, ready for repeated use.

MAPS

The teacher should be familiar with some of the ordinary map projections (see PG, Appendix D). The pupils should have already made some acquaintance with wall maps in earlier school years. The following exercise is found useful. Write on the blackboard the latitudes and longitudes of a series of points taken from the outline of South America, or Australia, or the Great Lakes, or from the branch work of an important river system, such as the Mississippi or Kongo; furnish outline maps containing only the network of parallels and meridians (Mercator, stereographic, or conical projection, as desired, traced from a map in an atlas and manifolded), and have the pupils plat the points upon it. Join the points by a line or lines. Ask the pupils what the lines represent; if they are uncertain, have them identify the outline by means of some of its latitudes and longitudes on a wall map.

A proper understanding of scale is important. A linear scale is a line that shows the distance on a map corresponding to a certain actual distance; the line is commonly divided into a number of equal parts, whose values are indicated. Scale may also be expressed by a fraction which shows the proportion of any distance on the map to the corresponding actual distance. Thus an inch to the mile is 1 : 63,360.

Some comments on map making are given below, under Excursions. Much use may be made of the topographical maps published by different governmental bureaus. A general account of maps of this kind is contained in a little book entitled "Governmental Maps for Use in Schools" (Holt, New York, 1893). Since its publication there have been various changes in the prices at which maps can be had; inquiry as to price should therefore be made before ordering. Articles by the author giving suggestions as to the choice of illustrative maps may be found in the *Journal of School Geography*, I, 1897, 200; II, 1898, 340, 386. The bureaus from which the most serviceable maps can be had (all but the last are in Washington, D.C.) are as follows:

Weather Bureau. Daily weather maps issued from various stations in different parts of the country as well as from the central office in Washington. A series of these maps should be regarded as indispensable. When exposed for current use by the public they may usually be had free. See below, EPG, Secs. 63–67. Address, Chief of the Weather Bureau.

United States Geological Survey. Besides the reports, monographs, and bulletins, this Survey issues topographical maps and geological folios. The topographical maps cost five cents apiece, or $2.00 a hundred. A selection of

these maps is indispensable in laboratory exercises. Lists of these publications can be had free on application to the Director.

United States Coast and Geodetic Survey. The charts issued by this Survey contain many admirable illustrations of coast forms. An illustrated catalogue and price list can be had on applying to the Superintendent.

Mississippi River Commission. Unequaled maps of a river of the first magnitude. See notes below, under Sec. 151. Address the Secretary, St. Louis, Mo.

The topographic maps of the United States Geological Survey express the form of the land surface by means of contour lines (EPG, 222); the charts of the Coast Survey indicate relief by hachures (EPG, 142, 316). The latter are more easily understood by beginners, but the former give more definite ideas as to form because they indicate the altitude of the surface as well as its general shape; hachure maps give little indication of actual altitude. Moreover, the contour maps of the Geological Survey already include a large part of our country and will in time cover all its surface; they are thus destined to be of great practical value, and all students of Physical Geography should be well trained in their use.

It is desirable that young pupils should make their first acquaintance with contour lines in the same manner as with isothermal lines, that is, by practical construction; also that the first exercise on contours should be devised not merely to illustrate what contour lines are, but to exhibit the land form that is at the time in process of study. The first need of using a map of this sort comes in connection with coastal plains, Sec. 97. Hence when that section is reached the teacher should place upon the

blackboard (or upon sheets of paper, by manifolding process) the numbers which represent the altitudes of various points on a land surface above sea level, as in Fig. 3 (omitting the dotted contours of 40′ and 80′); then have the pupils draw a line that shall separate all the land higher than 80′ from all the land lower than 80′; again for 60′, 40′,

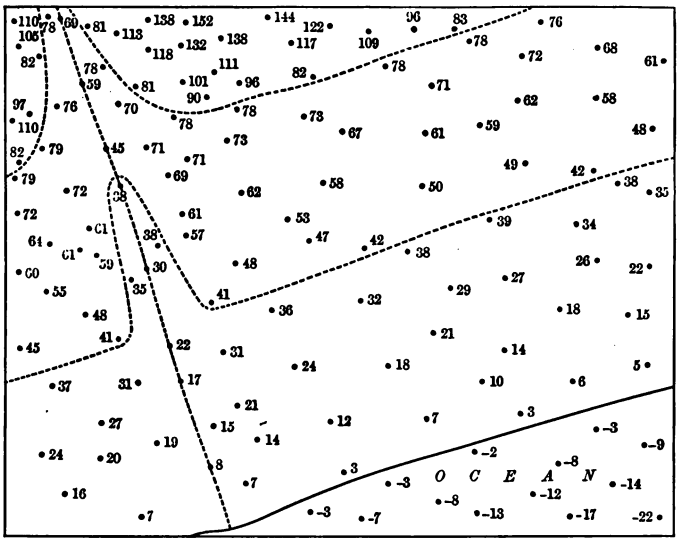

FIG. 3. Altitudes on a Coastal Plain

and so on for every twenty feet. (The exercise can be simplified, if desired, by omitting the left-hand part where a valley is indicated.) Show that in following such lines one finds them to be level, always at the same altitude, however much they may turn to the right or left. The statement may then be made: "Lines of this kind are called *contour lines;* the difference of height of two adjoining contour lines is called the *contour interval.*" When the contour

map is completed, ask for a description of the surface that it represents: Where is the slope steep? where gentle? How is steepness of slope indicated by the spacing of the contour lines? If a valley is indicated on the map (as it will be found to be, if the numbers are used as in Fig. 3), draw a stream line along its bottom (here shown by a dotted line). In which direction does the stream descend? What is its average fall in a mile? As the contour lines cross the valley, do they turn upstream or downstream from their general course on the plain? Why? Which figures in the text-book represent land forms similar to the one here mapped? (*Ans.* Figs. 62, 63, 64.) What sort of a land form is here represented? What is the fall per mile on the coastal plain? on the hill slopes in the northwest part of the map?

If the teacher wishes to introduce additional exercises of this kind, the following plan should be followed: Draw a contour map of the form to be studied (or select an illustration on a published contour map); mark a number of dots on the map, as in Fig. 3; determine the altitudes of the dots by their position with respect to the contour lines; copy off the dots and their altitudes.

After a few diagrams of this kind have been used in practical exercises, one of the topographical sheets published by the Geological Survey may be introduced; but care should be taken that the sheet chosen should illustrate an example of the kind of forms then under study, and not merely a method of representing land forms by means of contour lines. If the class is at this time engaged on Sec. 98, the Bermuda Hundred, Va., sheet may be shown. The rough location of the sheet should be indicated on Plate A or B, at end of text-book, and the statement should be made: "This map represents part of the Atlantic coastal

plain in Virginia, somewhat north of the plain shown in Fig. 66." In order to get the best results it is well to make sure at the beginning that the pupils understand the map, as may be done by asking a few specific questions: What is the scale of the map? How many miles does the side of the map represent? the top? How large an area does it include in square miles? In what color are the streams printed? the roads and names? the contour lines? What is the contour interval? Which contour lines are heavier than the others? How is the altitude of the contour lines indicated?

In examining the form of the surface it is best to begin by directing the pupils' attention to a certain part of the map where the features to be studied are well shown. This may be done by inclosing a selected area in a rectangle or an oval marked lightly in colored crayon (or by cutting it out, as suggested above, p. 15). The inclosing line should be drawn so as to include a somewhat larger surface than the basin of one of the streams whose entire drainage area is shown; for example, Wilton creek, in the northern part of the map. Then ask such questions as the following: What is the length of Wilton creek from its head to its junction with James river? What is the altitude of its head? of its mouth? What is its fall per mile? From how far on each side of the stream does the surface slope towards it? Trace with a small pointer the boundary of the area drained by the stream; this boundary is called a *divide*, because it divides the slopes that descend into adjoining valleys. What is the general form of the uplands on which the divide lies? Compare the curves of the contour lines where they cross the stream, with the curves where they cross the divide. Explain the difference. Find the highest point on the divide. (Near

Edvins, 200′.) Are many points on the divide of about the same height? What is the (rough) average measure of local relief (difference of altitude between valley bottom and neighboring divides; see EPG, 147). Draw a cross profile of the valley on a NW. to SE. line, half a mile southwest of the Varina road.[1] Finally: How may the general form of the district here shown be described? (*Ans.* A partly dissected plain; EPG, 147.)

Questions of this kind are useful to beginners, because it is only by "spelling out," as it were, successive parts of the map that the whole of it can be intelligently put together. When some facility in the interpretation of maps has been acquired, these elementary questions would be as much out of place as spelling would be in the study of a printed page by one who can read. A number of maps that serve to illustrate the text are named in the References for Maps (EPG, 386–388).

[1] To draw cross profiles or sections from contour maps: Fold a blank sheet of paper along a line over which it is desired to draw the profile. Lay the folded edge along the line of the desired profile on the contour map. Mark with a sharp pencil the points where the contour lines, the streams, and the divides meet the folded edge, and indicate the heights of some of the contours by figures. Unfold the paper, and draw a vertical line near one end on which the scale of heights or altitudes may be marked. (If coördinate paper is used, its ruled squares serve to mark the scale.) The scale is usually made from three to five or ten times larger than the horizontal scale, in order to represent the relief of the profile more distinctly; but it is well to make this vertical exaggeration as little as possible. Over each point noted on the base line, which represents sea level, mark a dot to indicate the height of the corresponding contour, etc., according to the scale of heights. Join the dots by a curved line; this is the cross profile of the valley. Different pupils may draw cross profiles at different points along a valley. If the profiles are then cut out and set up on the map in proper position the form of the valley will be expressively indicated.

The folios of the Geologic Atlas of the United States, of which some eighty numbers have now been published by the United States Geological Survey, at prices varying from 25 to 50 cents each, are of great service in that they contain an explanatory text giving excellent physiographic descriptions of the area that they cover and of the region in which this area is included. Their style is as a rule so advanced that young pupils may find difficulty in reading them; but to the teacher they are of great value. The folio for the nearest district to the school should be secured if possible.

Three folios of a Topographic Atlas have been issued by the Geological Survey. The first two contain a number of physiographic types, illustrated by contour maps with descriptive text. The third is devoted to Texas, and gives a great amount of information concerning that state, in verbal, cartographic, and pictorial form.

GLOBES AND MODELS

A good globe, of as large a size as possible, is of great service in illustrating many broad problems of distance and distribution which cannot be treated satisfactorily on maps, because of the necessary distortion on maps of large parts of the earth. See notes, below, on Sec. 68. A number of small hand globes are of value in practical exercises on problems of distribution and dimensions of land and water, etc. Globes showing the relief of the lands and the depths of the ocean basins necessarily exaggerate vertical dimensions so greatly that if they are used at all, much care must be taken to correct the wrong impressions that they suggest. The scale of the globe used should be determined by the pupil. What is the fractional scale of a globe whose

diameter is 7.9 inches? (*Ans.* 1 : 63,360,000.) A linear scale for such a globe would be an inch to 1000 miles. If this scale is marked on a strip of paper and laid on the globe, it may be used for measuring distances; for example, how far is it from San Francisco to Yokohama?

Models of the continents, of the United States, and of single states are of much value if they are carefully constructed without too great vertical exaggeration. Models of various regions, including a set of the continents, are sold by E. E. Howell, 612 17th Street, Washington; one of the best of these represents the United States on a curved surface, showing the true curvature of the earth. A set of models of the continents and the United States is sold by the Western School Supply Co., Chicago. All these models serve chiefly to give general ideas of location and relief; they are on too small a scale to give good illustrations of actual form.

Illustrations of typical land forms have the same relation to models of states and continents that selected series of typical plants have to all the plants actually growing in a large district. In both cases it would be very difficult to impart accurate ideas concerning the large groups of diverse forms unless some clear knowledge of the elementary forms had first been acquired. Hence the importance of studying the various kinds of land forms, and the need of illustrating them by typical examples. It was with this principle in mind that the Harvard geographical models were constructed a few years ago by Mr. G. C. Curtis, under the direction of the author. Their scale may be taken as one or two inches to a mile. The models (see EPG, Figs. 60, 62, 104) are of much practical value in teaching changes in continental outline (Sec. 91), the general dissection of the lands by river valleys (Sec. 94), young coastal plains

(Sec. 97), lofty mountains (Sec. 112), embayed mountains (Sec. 125), young volcanoes (Sec. 127), graded rivers (Sec. 147), deltas (Sec. 154), glaciers (Sec. 171), and shore lines of different kinds (Secs. 178, 180, 182). Special exercises in description or in mapping may be assigned on certain parts of the models in connection with each of these topics. Being much more realistic than maps and diagrams, models of this kind are particularly helpful with beginners; being of small or no vertical exaggeration, they give truthful impressions. The three models are sold by Ginn & Company, Boston. A pamphlet describing their chief features may be had of the Boston Society of Natural History, Berkeley Street, Boston; price 25 cents.

EXCURSIONS

The teacher should take advantage of every opportunity of studying nature out of doors, and should strive to become familiar with actual examples of as many kinds of physiographic phenomena as possible. It will be found practically useful to look over the text-book, section by section, to see how far personal acquaintance with the facts there described has been made, and to discover how far this acquaintance may be extended. The earth's rotation, the change in the direction of sunrise and sunset with the seasons, the form of clouds, the range of the tides, the weathering of rock ledges, the washing of rock waste, the behavior of streams, the forms of shore waves, all these and many other facts should become personally familiar, as far as the teacher's field of observation includes them. This is particularly important in connection with the observational study of land forms. No set instructions can be given for this study, because the field of observation varies so greatly

from place to place. Summer vacation excursions should be carefully utilized; brief notes, outline maps, and diagrams should be made whenever possible, but always with the attempt to refer the things seen to the class in which they belong. The topographical sheets published by the United States Geological Survey are of great service when the teacher is traveling over districts which they cover; their extremely small cost makes them available to every one.

Although there are many practical difficulties in the way of school excursions, the difficulties are as a rule not insurmountable; and it is certainly a fact that school excursions are becoming more common year by year. When they are carefully planned and well conducted, there can be no question of their value. Good order should be maintained. On the way to and from the points of special study, the class should be restrained only by the rules of good behavior; but while at work studying the points selected by the teacher, close attention should be required of each pupil.

Excursions in the autumn are best applied to the study of local illustrations of the general features of the lands (EPG, Chap. IV, especially Secs. 92, 93, 94) and to the acquisition of simple methods of outline mapping (see below). If a rock ledge or a quarry is visited, let it be regarded as showing a sample of one of the many kinds of rocks of which the earth is made, and let the pupils discover all they can about it. Do not tell the name by which the rock is known until the pupils can describe the features by which they would recognize it if they found it in another ledge. So with the minerals that often may be recognized as rock constituents: do not tell their names till some of their physical peculiarities are found out, and be careful to regard all such specimens as samples of the many kinds

of things of which the earth's crust is composed. The weathering of rocks in ledges and quarries, and the production of the surface mantle of waste should be studied as examples of the process that has been always going on upon the lands, and as the introduction to the general process of land sculpture.

The wash and creep of the waste down hill can hardly be observed on slopes covered with grass or forest, but it may be easily recognized on bare slopes, especially if rain has fallen not long before the excursion. The delivery of waste from a valley side to a stream in the valley bottom, and the active transportation of the finer waste by the stream can be well illustrated in many localities.

Careful questioning by the teacher will lead the pupils to see that although a stream may deepen its valley it cannot wear the valley bottom below or even down to sea level, for the stream must have some slope on which its water shall run; thus the principle of baselevel is encountered. The term *baselevel* may be introduced or not, as the teacher wishes; it will be met in the text (EPG, 145). Again, the pupils may be led to discover that if weathering and washing go on indefinitely the hills will be worn down lower and lower until the land surface would be a plain or nearly a plain; thus preparation is made in view of the facts of nature for the general idea of the geographical cycle resulting in a peneplain (see below, notes on Chap. IV), and for the explanations met in Secs. 106 and 123. If such changes are expectable in the future, some of them may already have taken place, in part at least; thus the existing hills and valleys may be interpreted as representing the present stage in a long series of changes, and so the way is opened toward the rational treatment of land forms in general.

The opportunity for elementary field work varies greatly as to minor topics in different parts of the country. Wonderfully suggestive illustrations of the general principles of land sculpture are found in nearly all parts of the country south of the area of glaciation (EPG, Fig. 151). Within the glaciated area it requires more care to conduct an excursion so that relatively advanced problems shall not take too prominent a place. See notes on Chap. IX.

Excursions in the spring should be directed to determining the stage of development reached by the best accessible examples of land and stream forms, and careful practice should be given in the description of these forms in terms of their stage of development. Process of change and past history of development cannot be neglected in such study, but they should be subordinated to the observation and description of existing forms. Indeed, past process and history have a place in physiography only in so far as they aid the student to see and understand the present. Furthermore, all the examples of land or stream form encountered in the spring excursions should be treated as belonging to known classes of forms, explained in the text-book, and holding systematic positions in those classes. The study is greatly broadened by thus establishing a systematic relation between local facts and the general discussions of the text.

Let it be supposed that a stream is visited. If local rapids are found in its course, they should be described as "not yet worn down to grade with the even stretch next below them"; while the ledges or bowlders by which the rapids are determined should be recognized as "the local baselevel with respect to which the next stretch upstream is already graded." If narrow strips of flood plain are found, they should be treated as "the beginnings of what will in time

be a broad valley floor"; if a leisurely stream with free-swinging meanders is discovered, it should be regarded as "the later development of what was once a hurried stream, descending on a nearly direct course." The intention of these phrases is to enforce attention upon existing features by comparing them with other features of systematic occurrence.

Care should be taken that separate items of observation are not left to stand alone in the pupil's mind, but that they should be associated with other items, observed or fairly inferred, so that they shall take their proper relative positions in a systematic treatment. Otherwise the result of field work is apt to be only a series of disconnected and therefore apparently trivial details. After local study of a hill or spur in a dissected plain or plateau, it should be explained to be only a small part of the whole to which it belongs. When a stream has been followed, it should be placed properly in the river system to which it belongs. Maps are serviceable in this part of the work. It is particularly in this connection that the experience and ingenuity of the teacher are drawn upon to aid the pupil. It is well to remember that a young pupil's power of expression is below his power of understanding; and hence that if written reports of observations are called for they will frequently give imperfect indication of what the pupil has learned and be of relatively small value to refer to afterwards if the teacher has not given due assistance in the matter of phrasing, especially when items of observation are extended into generalizations.

Pupils should be aided in making sketch maps of at least a part of the district covered by the excursions, and for this purpose it is desirable that the teacher should be already well practiced in making such records. It is well to begin

on a hilltop or rise of ground, whence some roads, houses, fields, streams, etc., may be seen. Hold the notebook so that the top of the page is turned to the north; adopt a linear scale appropriate to the area to be mapped; draw lines on the page parallel (as well as can be estimated) to the roads, fences, etc., that are easily seen; locate the houses and other landmarks as well as may be. The outline thus made will serve as a basis to which other data are added as the excursion proceeds. Corrections of the first drawing must be frequently made, especially if opportunity is given for taking the compass bearing or for pacing the length of a road that is followed after it has been sketched. The map may prove to be a very rough affair, and may show very imperfectly the features of the district visited, but it will serve a valuable purpose in impressing on the pupils how great an amount of labor and how high a degree of skill has been required in the preparation of such maps as those published by our governmental bureaus. It must be remembered that in preparing such maps, observations can be made at any one point only as far as eyesight (or sometimes telescopic sight) will carry; hence all parts of the country must be successively visited, and a great number of local maps must be put together and drawn on reduced scale in order to make a map of a state. The surveyor is aided by appropriate instruments, but no instruments can obviate the necessity of actually going over the ground in order to discover the location of its various elements of form. The maps in atlases and school geographies, for example, from which one learns the location of mountains, rivers, and cities, have all been made essentially by a repetition of the simple work that may be illustrated in an afternoon's excursion. It is very desirable that pupils should gain in some such way as this a realizing sense of

the manner in which maps are constructed and of the labor that they cost.

It is important that excursions should be carefully planned, but it is usually impossible as well as inadvisable to limit the observations on such excursions precisely to predetermined topics. Let the main objects of the excursion be clearly defined in the teacher's mind; let the observations that are required of the pupils illustrate these objects as closely as possible; but encourage additional observations, explain them as far as time permits, and urge the pupils to make brief records of what they see and hear. Reference to these records — or to the memory of the excursions — may be made when the facts are successively encountered in the study of the text-book.

Suggestions regarding field excursions may be found in several articles by the author: "Home Geography," *Journal of School Geography*, I, 1897, 3–7; "Field Work in Physical Geography," *Journal of Geography*, I, 1902, 17–24, 62–69, as well as in various articles by other writers.

CHAPTER I. — THE EARTH AS A GLOBE

1. The second paragraph of Sec. 1 gives the key to the plan of the book: the physical features of the earth are first described and explained, and then traced to their consequences as seen in the condition of the earth's inhabitants. While the explanations are sometimes so difficult and the consequences are sometimes so remote that they are advisedly omitted from an elementary text-book, the teacher will find profitable exercise in forming the habit of trying to connect every item of Physical Geography (or Physiography) with its physical causes and its organic consequences.

2. The "familiar argument for the globular form of the earth, based on the disappearance of the lower part of distant vessels at sea" is here intentionally referred to as already known. It certainly should be known from previous study to every pupil who takes up the subject of Physical Geography. If by chance it is not known, that defect must be corrected in the individual case where it happens; but such occasional defects are not a sufficient reason for repeating at length an elementary demonstration that ought to have been learned in an earlier course on general geography.

5, 6. Special attention should be given to the "consequences" mentioned in these sections. There can be no question that the widespread distribution of many plants and animals and the extensive commerce of modern times are consequences of the nearly globular or *level* surface of the earth, on which movement is comparatively easy. The importance of the near approach to globular form is emphasized by the great effect of mountains as barriers (Sec. **115**), although the highest ranges are very small compared to the earth as a whole. Note that the convex surface of the globular oceans is "level," not "horizontal"; and that the continents, viewed as a whole, are nearly level. A horizontal surface is a *plane* tangent to the globular earth at any point. For small distances from the point of tangency, horizontal and level surfaces sensibly coincide. This may be made clear by the use of a globe.

7. The fact of the earth's rotation is made more vivid by setting up pointers radiating from a common center and directed toward the sun at different hours of the day. On the following day, note that the sun comes to the line of the first pointer from the east, as if completing a circle around the earth. A pencil held at right angles to the

plane of this circle is parallel to the earth's axis. (The pointers do not always lie in the plane of the circle.) The sun seems to move around from east to west, because the earth turns from west to east. See Sec. 18.

8. Certain physiographic items are here presented not simply as independent facts but as controls of the standards of time and direction used by man in so many ways.

9. Latitude and longitude should not be presented as mathematical abstractions, but as ingenious devices by which man practically uses the form and rotation of the earth for the determination of his position upon it. A globe should be here used for illustrating these devices. The teacher should be thoroughly familiar with the methods of determining latitude and longitude as given in the author's "Physical Geography" and in Sec. 62 of the "Elementary Physical Geography." If the pupils have had good previous training, the actual determination of local latitude and longitude by some of these methods will be more valuable than the review of previous study in Sec. 9. See also the author's "Practical Exercises in Geography," *National Geographic Magazine*, XI, 1900, 65–71.

10. The figure of the earth's orbit, constructed as here directed, is so nearly circular that its elliptical form is hardly noticeable. Figures of the orbit ordinarily given grossly exaggerate the departure of the orbit from a true circle. The following profitable exercise, easily within the reach of young pupils, will aid in realizing the revolution of the earth around the sun. Note a group of stars in the eastern sky after sunset; repeat the observation about once a month through the autumn and winter; what inference may be drawn from the facts thus observed? Evidently

the direction of the sun-earth line changes from right to left. If the observations are continued long enough, the sun-earth line will be found to come back to its original position. How long must observations be continued to discover this fact? What conclusion may be based on it? It is of course necessary that all this must be perfectly clear to the teacher before he can profitably teach it.

15. Samples of a few different kinds of rocks may be shown to advantage in connection with this section, as well as with Sec. 93. See notes on Chap. IV. Evidence of the great age of the earth will be found in the various chapters on the forms of the lands, where it will be shown that no just understanding can be gained of the earth's surface except on the supposition that an indefinitely long series of changes has taken place upon it. See especially Secs. 106, 123.

CHAPTER II. — THE ATMOSPHERE

20. Note that plants as well as animals breathe air and use some of its oxygen, etc.; but the quantity of air breathed by plants is very small. It is a popular error to suppose that plants and animals are unlike in this respect. They are unlike, however, in another respect: plants subsist largely upon the carbonic dioxide of the atmosphere, which forms no part of the food of animals. Nitrogen, the chief constituent of the atmosphere, is an inert gas, of no direct use to plants and animals.

21. A mercurial barometer is of great importance in illustrating the pressure of the atmosphere. The pupils should be made to realize that the mercury is pushed up in the tube by the downward pressure of the air on the mercury in the vessel at the bottom of the instrument. A piston fitted in a glass tube may be used to illustrate

the principle of the ordinary pump, as far as it is dependent on air pressure. The word *suction*, commonly used in this connection, implies a misunderstanding of the forces involved. When the lower end of the tube is placed in water and the piston is raised, the water beneath it is relieved of pressure; the water follows the piston up the tube because of the downward atmospheric pressure on the water surface in the vessel from which it is "sucked up."

Observations of the barometer and thermometer are conveniently shown graphically, by plotting dots in the

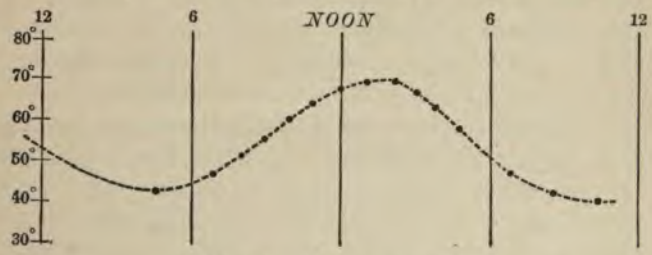

FIG. 4. Diurnal Temperature Curve

proper position with respect to a horizontal time scale and a vertical pressure or temperature scale, as in Fig. 4.

23. The colors of the sky and of clouds should be recorded from direct observations by the pupils. The more intelligent pupils should be advised to make occasional record of the distribution and changes of sunrise and sunset colors, noting the time interval from sunset or sunrise at which various colors are best seen. The value of sunset colors as weather indicators may be thus learned. In our winter climate of rapidly changing weather, a very clear sunset usually marks the middle of a fair-weather spell, soon to be followed by a change to cloudy weather. The colors in the sky opposite sunrise and sunset should also

be noted. Very few persons seem to know that the dull blue sky under the rosy twilight arch opposite sunrise or sunset is in the shadow of the earth.

27. The pupil will easily understand that the observations of temperature here charted in Fig. 11 are similar to those he may have made at home or at school. Again, the data for Fig. 12 should be explained as being dependent on observations gathered from all parts of the world, where they have been patiently recorded by numerous observers. Records made on shipboard are brought together in the government offices of various countries, — as in the Hydrographic Office of the Navy Department at Washington, — classified according to their latitude and longitude, and then averaged. Hundreds of thousands of observations have thus been made and discussed. The same is true of the winds (Secs. 29, 31, 38) and of rainfall (Secs. 50, 51). It is important that pupils should not on the one hand believe that the charts representing these climatic elements are "ready made," and that they should not on the other imagine that the preparation of the charts has involved any mysterious process. The charts simply represent the results of a great amount of painstaking, persevering observation by many individual observers.

27, 36, 37. The topics here treated should be supplemented by abundant questions upon Figs. 12, 18, 19, 20. Besides the questions given in the text, the following are suggested. Describe (or draw outline maps to show) the location of the heat equator for the year, January and July. Where and when does the heat equator depart farthest from the geographic equator? What is the cause of this great departure? Where are the isotherms most crowded on Figs. 18 and 19? Describe the distribution of temperature indicated by this crowding; explain it. Where are

the isotherms farthest apart? Why? What is the difference between the January and July temperatures of Newfoundland (or other place) as given in Figs. 18 and 19? What is it according to Fig. 20?

28–40. It may be pointed out that the plan of presentation from Sec. 28 to Sec. 40 and beyond is to pass from the general to the particular. The opposite order is permissible if desired; but it is less effective when young pupils study this problem, where the passage from the particular to the general would be a passage from the relatively complex and varied to the relatively simple and orderly. The association of temperatures, winds, and rainfall in the planetary system is easily apprehended; it is divested of all complications, and serves as a simple type on which certain systematic variations are to be played when the effects of changing seasons are introduced. The terrestrial system is thus logically developed; such features as the subtropical belts (p. 55), so essential for the explanation of the winter rains of California, for example, are seen to take an orderly place in the scheme of nature. The further complication of the terrestrial system by the continents (Sec. 40) by no means exhausts the subject, but carries it to as great a degree of complication as beginners can be expected to follow. Later sections on tropical cyclones (Sec. 49), rainfall (Secs. 50, 51), weather changes (Secs. 52–58), climate (Sec. 59), amplify various elements of which more or less account has already been given; and all these elements should be referred back to their place in the general system of which they are but parts.

28. It is futile to attempt any detailed explanation of the general circulation of the atmosphere in an elementary course. The problem is too difficult. Its essential features are stated in the author's "Elementary Meteorology,"

Chap. VI, to which the teacher may refer with advantage. The young student's attention is sufficiently occupied with the leading facts concerning the lower currents or winds. As to omission of charts showing the distribution of pressure over the world, see Preface, p. vii. In case it is desired to make reference to such charts, they may be found in the author's "Elementary Meteorology," and a logical method of using them with pupils of a sufficiently advanced grade may be found in an article on "Meteorology in the Schools," *School Review*, II, 1894, 529–539.

It is well to avoid such statements as, "The warm air around the equator rises, and the cooler air rushes in from each side to fill the vacuum thus produced." The proper statement is, "The warm air around the equator is raised by the underflow of cooler, heavier air from each side." Again, the slowly raised equatorial air is not cooled "because it rises into cooler regions," but because of its own expansion as it rises: rising air would be cooled by its expansion even if the upper regions of the atmosphere were warm. This is important in connection with the cause of rainfall (Sec. 30. See also note on Sec. 43, below.) The formation of clouds by the cooling due to expansion is well illustrated in the production of cloudlike masses (popularly called "smoke") in the expanding steam that issues from the stack of a locomotive.

31, 38. Although the actual winds of the earth's surface exhibit many irregularities it is important that the general schemes of planetary and terrestrial winds should be well apprehended, because they afford so much aid in remembering the general course of the winds over large regions. The associations of rainy and dry belts with the wind systems is much more advisable than the separate teaching of winds and rainfall. The leading features of the climatic

zones can easily be remembered by means of these associations. Test this by reviewing the subtropical belts and their explanation. It should be recognized that the large atmospheric whirls described in Sec. 32 are characteristic features of the prevailing westerly winds.

33, 34, 35. It should be the teacher's effort here to carry the explanation of the seasons further than it has been given in the pupil's previous study of Geography. For this purpose the practical observations described in Sec. 61 are of great utility. The teacher should be familiar with these observations by actual performance and record, and the teacher's record of an early year may be freely used to supplement the pupil's record when necessary.

39. Note that monsoons would occur systematically all around the subequatorial belt (Fig. 21) if the migration of the heat equator (Sec. 35) were uniform in all longitudes. The migration of the heat equator has, however, been already shown to be irregular (Sec. 36, Figs. 18, 19). Monsoons must therefore be expected only where the heat equator departs significantly north or south of the geographic equator. The greatest departure is over southern Asia, and there monsoon winds are developed over the greatest area (Figs. 22, 23). Another great departure in latitude is in Mexico, but as this extends over only a moderate distance in longitude, and as the mountains of North America trend southeast across the course that the winds should take, monsoons are here much less developed than in southern Asia; they may be recognized, however, in the northerly winter winds and the southerly summer winds of the Texas coast, although the name, monsoon, is not employed there.

The northwest monsoon of January in the Indian ocean, next south of the equator (Fig. 24), is too generally omitted

in the elementary study of climate, not because every climatic fact is perfectly understood, but because it is important to form the habit of trying to explain all facts by performing exercises on selected facts that can be easily explained. The unlikeness of the north and south temperate zones should be emphasized.

60. The explanation here given should serve to correct the popular misapprehension regarding the deflective effect of the earth's rotation. It is wrong to suppose that only bodies moving north or south are deflected. In a given latitude a body moving east or west is just as much deflected as one moving north or south, the velocity being the same in the two cases. The course assumed by the wind under the combined action of differences of pressure and the earth's rotation is explained in the author's "Elementary Meteorology," p. 105.

61. The intention of the exercises here described is to associate the various elements that run through their cycle of change in the course of a year. Observations indicating the earth's revolution around the sun, as suggested above, under Sec. 10, make a valuable additional exercise in this connection. See the author's "Practical Exercises in Geography," *National Geographic Magazine*, XI, 1900, 73–78.

62. It is sometimes the case that young pupils are taught to determine latitude by observations of the sun's altitude, the declination of the sun being taken from the Nautical Almanac. Such a method is not appropriate for beginners; it is unscientific in so far as it includes an element (sun's declination) not determined by the pupil's own observation. The method suggested in Sec. 62 is free from this defect, because here the pupil determines the sun's declination for himself. Even if some of the observations by which the curve of Fig. 32 is determined have been

furnished by the teacher, the nature of the observations and of the curve that results from them can still be properly appreciated by the pupil; but data taken from the Nautical Almanac must be empirical even to students several years older than those who are ready to begin the study of Physical Geography.

63–67. All these exercises are presented in much greater detail and with abundant illustration in Ward's "Practical Exercises in Meteorology" (see above, under Secs. 52, 58). The time required for the exercises here described can be much shortened without lessening their profit, if the readings of pressure, temperature, etc., are transferred to outline maps of the United States by any one of the various manifolding processes now in use. The time of plotting the readings can thus be saved, and the pupils may proceed directly to the drawing of isobars, isotherms, etc.

Again, the determination of the tracks of cyclonic or anticyclonic centers is facilitated by dividing a class into sections and letting each section prepare a map for a certain date. The location of the pressure centers determined by the several sections can next be dictated to the other sections, and the tracks can then be drawn. The number of profitable exercises is so large, and the time that can be reasonably allotted to laboratory work is necessarily so limited, that great care should be taken to waste none of it in needless manual constructions.

CHAPTER III. — THE OCEAN

68. A globe is indispensable for the proper study of the distribution of land and water. Let the pupils see if any other division of the water and land hemispheres than that shown in Fig. 34 will have more water in the first and less

water in the second. Measurements of the dimensions of the oceans may be made by the method described above, p. 26.

72. The saltness of the ocean is no mystery (as it seems sometimes to be considered), but the most natural result of the washing of the lands by rain and rivers for ages past. Do not allow the pupils to gain the idea that the deep ocean is so dense that heavy bodies will not sink through it to the bottom.

76, 78. The absence of valleys and the accumulation of sediments on the deep ocean floor are important in contrast with Sec. 94. The deposit of land waste in the seas bordering the continents, the arrangement of the waste in layers or strata (singular, *stratum*), and the preservation of organic remains as fossils in these strata are important items in preparation for Secs. 96, 97.

79. The movement of waves through standing water should be learned by observations on ponds or reservoirs, whose surface is rippled by the wind. In Fig. 42 the wind is supposed to be blowing and the waves moving from left to right. Notice that the orbital movement of the water in the wave crests agrees in direction with the wave movement, while the two are opposed in the wave trough. In the rising part of the wave (to the right of the crest) the orbital movement is upward, and in the sinking back of the wave (to the left of the crest), downward. The orbital movement is much slower than the wave movement. The height of the orbit equals the height of the wave from trough to crest. The size of the orbits rapidly decreases beneath the water surface. A water particle moves once around its orbit in the time between the passage of two wave crests. See below, p. 51.

81. Note the explanation of surf in the third paragraph of this section. The explanation ordinarily given ("the

progress of the wave is retarded by friction with the bottom, and hence the crest falls forward as it nears the shore") is erroneous. Friction with the bottom acts only on the orbital motion of the water in the wave, decreasing the size of the orbit; friction does not cause the wave to lean forward and topple over.

82. Earthquake waves are often but inappropriately called tidal waves. They are entirely independent of the tides.

83. The surface currents of the ocean are best explained as the effect of the prevailing winds and not as the effect of the difference of temperature between the equatorial and polar parts of the ocean. The latter cause, however, controls the slow movement of the deep waters from polar to equatorial regions, as stated in Sec. 74. See the author's "Winds and Ocean Currents," *Scottish Geographical Magazine*, XIII, 1897, 55; also *Journal of School Geography*, II, 1898, 16.

The chief reasons for this conclusion are: (*a*) the general agreements between the course of the prevailing winds (Figs. 22, 23) and that of the surface currents (Fig. 44); (*b*) the change of the currents in the monsoon region of the Indian ocean (PG, Figs. 46, 47), with (or shortly after) the change of the monsoons (EPG, Figs. 24, 25); (*c*) the faster average eastward movement of the North Atlantic drift in middle latitudes (and presumably of other oceans also) during the winter season of strong winds and gales than during the summer season of lighter winds and fair weather; (*d*) the temporary variation of the surface currents during adverse gales. The effect of the prevailing westerly winds as well as of the trade winds is important in causing surface currents. It is an error to ascribe the currents to the trade winds alone. The best method of studying the

currents of the various oceans is by their departures from the typical eddylike circulation.

The following method of determining the movement of currents in mid ocean may be introduced. The position of a vessel, *A* (Fig. 5), having been determined by observations for latitude and longitude at noon, June 17, let it sail on a course and at a rate that would carry it to *B* at noon, June 18. The position *B* is thus determined by "dead reckoning." Observations then taken show the vessel to be at *C*.

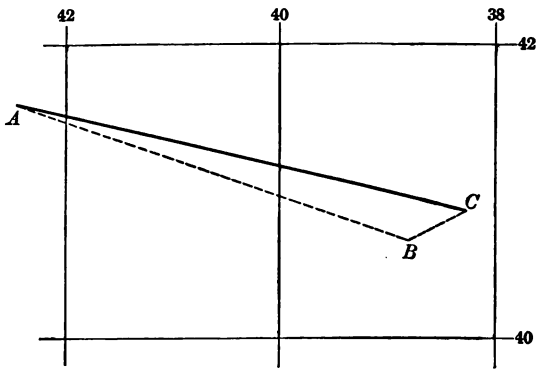

FIG. 5

The water through which the vessel was sailing must then be supposed (except for errors of observation, etc.) to have moved in the direction and over the distance *BC* in twenty-four hours. Thousands of determinations of this kind have been made in many parts of the ocean. Their results are generalized in Fig. 45.

84. This section suggests a review of Secs. 36, 59. There seem to be two extremes in the misunderstanding of the effect of ocean currents on the climate of western Europe. In one case the Gulf Stream is given an

exaggerated importance, being treated as a strong, deep current moving directly from the Gulf of Mexico to the shores of Great Britain and Scandinavia, where it is credited with performing prodigies. In the other case the climate of western Europe is held to be essentially independent of ocean currents. The truth lies between these extremes, and for its full statement the combined action of various factors is essential. Note first, as stated on p. 118, that the name Gulf Stream should be limited technically to that part of the North Atlantic circulation which has the properties of an ocean "stream," namely, a well-defined, narrow, deep, rapid current. Second, the Gulf Stream proper, as thus defined, joins that part of the North Atlantic eddy (Fig. 44) which flows outside of the West Indies. Third, the northern side of the North Atlantic eddy (about latitude 35° to 50°), thus supplied from the southwest, increases in breadth and decreases in depth and velocity, and thus becomes an ocean "drift." Fourth, in passing eastward, the drift divides, part of its waters returning past Spain and northwestern Africa toward the equator; part flowing slowly northeastward to the Arctic. Fifth, currents are impelled all through this course by the prevailing winds (Figs. 22, 23), except that the Gulf Stream in issuing past Florida is relatively independent of the winds. It may be added that the branch given off by the eddy on its northern side must be nearly equal to the branch received on its southern side; and that the latter branch, crossing the equator obliquely from the South Atlantic eddy to the North Atlantic eddy, is one of the most peculiar and most important members of the oceanic circulation.

Now as to the effect of the North Atlantic drift on the temperature of western Europe: First, if the atmosphere had no winds and if the ocean had no currents, the mean

annual temperatures of the ocean surface would agree closely with those of the lands in corresponding latitudes—true, the ocean would be less cold in winter and less warm in summer than the lands (Sec. 37), but in the mean of the year these differences would practically disappear. Second, as a matter of fact the circulation of the surface waters of the ocean causes a certain amount of interchange between torrid and frigid zones, and hence even in the mean annual temperatures the ocean surface is less hot around the equator and less cold in high latitudes than the corresponding lands (Fig. 12). Third, the oceanic region where the most notable tempering of the cold of high latitudes is found is precisely the region where the most active supply of relatively warm water is drifted, namely, the northeastern Atlantic; just as the oceanic region where the most notable tempering of torrid heat occurs is in the eastern equatorial Pacific, where the long reach of South America turns a greater body of cold water toward the equator than is turned anywhere else in the world. Fourth, the prevailing westerly winds necessarily carry something of the temperature that they gain from the waters of the northeastern Atlantic over the lands of northwestern Europe, and hence maintain the temperature of that region above the mean temperature of its latitude.

As to the Labrador current and the climate of northeastern America, the interaction is here less pronounced because the prevailing winds blow from land to sea; but where a cyclonic storm produces northeast winds the New England States realize that it comes from a chilled source, not so cold as the continental interior of Canada during winter, but unseasonably "raw" at other times. South of Nova Scotia the Labrador current has hardly any effect; the shore waters of New England have a temperature

appropriate to their latitude, but seem unduly cold by contrast with the warmer waters of the eddy farther from shore.

85, 87. The teacher should be familiar with the description and explanation of the tides in the author's "Physical Geography," pp. 83–87, 406–408. The association of tidal currents with tidal changes of level, and the explanation of this found by treating tides as waves, should be clear in the teacher's mind. See "Waves and Tides," *Journal of School Geography*, II, 1898, 122.

The essential features of this explanation are as follows: In an advancing wave the water rises with a forward

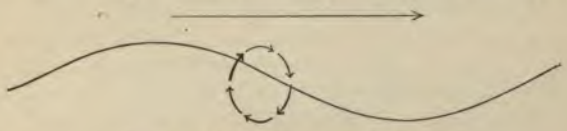

FIG. 6. Orbital Movement in a Wave

motion as the crest approaches, moves evenly forward as the crest passes, and sinks with a forward motion as the crest goes on; the water then sinks with a backward motion as the trough approaches, moves evenly backward as the trough passes, and rises with a backward motion as the trough goes on. Any part of the water thus moves through a vertical orbit, as in Fig. 6, the heavy rising arrow here indicating the water movement in the front of the wave, while the long arrow shows the direction of wave advance. Adjacent parts of the water body occupy different parts of their orbits at the same moment. Each particle reaches the top of its orbit as the wave crest passes it. All this may be verified by observation in a pond on a windy day.

Now the tide is a long, relatively very low wave; high tide is the crest of the wave, low tide is the trough, and

the tidal currents (flood and ebb) are the orbital motion of the water in the tide wave. The water orbit is a long and very flat ellipse, as in Fig. 7 (although the height is here too great for the length — the height may be less than ten feet for a length of several miles). At the time of high tide the flood current is moving evenly forward with, but not so fast as, the tide wave. As the high tide advances farther along the shore or up a bay, the flood current continues to run forward, but with a slight descent and with a slower and slower current until slack water (no tidal current at the end of the orbit) is reached; then ebb current sets in, continues past low tide until slack water of the

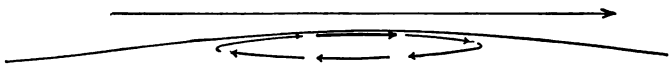

FIG. 7

next rising tide, when flood current begins again. In an ordinary wind-made wave the period of movement around the orbit is seldom over 7 or 8 seconds; in the tide wave the period is 12 hours 26 minutes. It is thus seen that the common belief that flood current runs from low tide to high tide, and that ebb current runs from high tide to low tide, is erroneous.

A brief statement of the cause of the tides is thrown into a supplementary section (Sec. 87), because for beginners the phenomena are more important than their explanation. No explanation is satisfacory that does not make it perfectly clear that *one tide-producing body must cause two tides.* Until pupils can really understand such an explanation it should suffice merely to state that the tides are caused by the moon; the time allotted to the study of the tides can then be given to tidal phenomena instead of to tidal theory. See the Preface (EPG, vii) as to why

the chart of oceanic cotidal lines, so often published, is here omitted.

The best practical illustration of the combined effect of lunar and solar tides (EPG, 125, 126) is as follows: Let

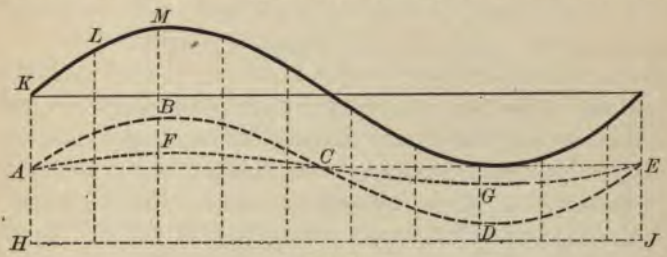

FIG. 8

the range of a lunar tide be shown by the curve *ABCDE*, Fig. 8, and of a solar tide by *AFCGE*. Draw a base line *HJ* beneath the curves. Draw several verticals from the base line to the curves. Add the heights of the curves at each vertical, and mark dots to show the sum of the heights,

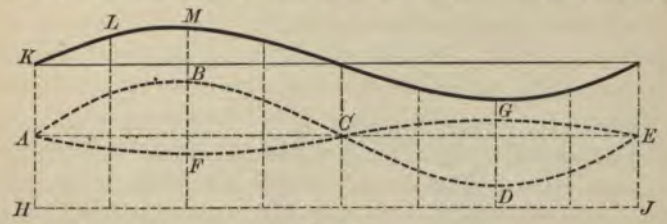

FIG. 9

as *K*, *L*, *M*. Draw a curve through the dots; this curve will represent the range of the combined lunar and solar tides. Fig. 8 shows the combination for new and full moon, where the tides act together in spring tides. Fig. 9, for first and last quarter, when the solar tide opposes and weakens the lunar tide, causing neap tides. Notice that

at spring tide not only is the high tide unusually high but the low tide is unusually low also; hence such tides should be called *strong* (not high). Similarly, neap tides should be called *weak* (not low).

CHAPTER IV. — THE LANDS

91–95. These sections treat what may be called the general features of the lands; thus they correspond to the sections on the general features of the globe (Secs. 2, 6, 13, 14, 15) in Chap. I, of the atmosphere (Secs. 19, 20, 21, 22) in Chap. II, and of the ocean (Secs. 68, 71, 72, 73, 76) in Chap. III. Of all the general features of the lands, the weathering and washing of the surface may be regarded as of the greatest importance in Physiography, because land forms are thereby so largely determined. The chief result of weathering and washing is the development of branching river and valley systems by which the lands are so systematically dissected. Rivers armed with land waste may therefore be regarded as the tools by which land masses are carved, and valleys are the tool marks. See Sec. 143.

The essential characteristics of river and valley systems as leading elements of land forms should be emphasized in connection with Sec. 94. Neighboring branch streams join, and the stream thus formed, receiving still other branches, unites with another stream to form a main or trunk river in a main or trunk valley; thus there is a branch work (not a network) of valleys, each drained by the local member of the corresponding river branch work. It may be reasonably inferred from the branch work of the valley system, and from the important fact that confluent valleys join each other at a common level, that valleys are

the work of the streams that drain them; for branch valleys joining at accordant levels *must* result from long-continued action of streams, and no other process can be imagined by which these specialized features can be produced. This suggests a reference to Sec. 15.

Many elementary illustrations, available for country schools, of the processes of stream work in eroding valleys may be found in the roadside gullies worn by wet-weather streams. Similar illustrations of much value may be easily made by sprinkling a heap of sand or clay with a hose. See a suggestive article for young pupils by L. C. Patterson, "Work of the Water Giant," *Journal of School Geography*, III, 1899, 5-12. In the suburbs of Chicago remarkable examples of rapidly eroded miniature valleys are seen in the ridges of earth that have been heaped up in excavating the canal connecting Lake Michigan and the upper waters of Illinois river.

There are several important principles that the teacher should bear in mind in this connection. If weathering and washing continue indefinitely, any uplifted mountain or plateau or plain, of whatever altitude, extent, or rock structure, will in time be worn down smooth, close to sea level or "baselevel." The time needed for the accomplishment of this great task is called a *geographical cycle;* the wearing down of a region of weak rocks may be accomplished in a shorter cycle than is needed in a region of resistant rocks. During the progress of a cycle different forms are successively produced in essentially systematic order; young regions preserve the broad forms due to initial uplift, as yet little carved by valleys; mature regions preserve little or none of their broad initial forms, for they are thoroughly carved by branching rivers in ramifying valleys; old forms are worn down to low relief. The

earth is so old that all the lands would be now worn down low and flat were it not that various parts of the earth's crust have been uplifted at different times (Sec. 91), thus starting a new cycle of changes. Evidently, then, the highest existing mountains must have been raised in the later stages of the earth's history.

All these principles are important in Physical Geography not merely because they are true but because they afford the most effective means of describing land forms. If a region is spoken of as "young" or "old," the trained geographer can thereby infer many of its characteristics. Abundant illustration of the importance of time as an element of physiographic description will be found on later pages.

A few kinds of minerals and of rocks (some stratified, some crystalline) may be profitably shown in this connection: specimens gathered from the local field may be exhibited and described, but there is not time to introduce here a systematic course on minerals and rocks. The specimens that are shown should be made to illustrate the question in hand (varied composition of the lands) and not to teach systematic mineralogy or geology. At the same time the processes and results of weathering should be illustrated as far as possible by local examples. These are commonly afforded by ledges, gravestones, road cuts, and quarries in the country, and by the building stones of different edifices in cities.

It is extremely desirable that the teacher should become familiar with the general principles stated above, and with their illustration in the school district. Advantage should be taken of every opportunity for seeing facts in the field, and every fact should be mentally associated as clearly and systematically as possible with the general principles under which it belongs. See suggestions for Excursions, above.

CHAPTER V.—PLAINS AND PLATEAUS

The method of presentation adopted in this and the five following chapters secûres a definite knowledge of the simpler kinds of land forms, and especially of such forms as may come under observation in the pupil's later years. It is not advisable to describe large regions in general terms. The pupil's attention should be held to relatively small areas over which the form of the land can be analyzed with some care. The areas selected must be presented in a carefully considered order, from simple to complex. At the same time each kind of land form must be traced through the orderly sequence of changes that it suffers from the destructive attack of weather and water with the passage of the ages; for, on recognizing that land forms do actually suffer systematic changes from youth through maturity to old age, it becomes much easier to describe the forms appropriate to the particular stage of development in which any given example is found to-day. By no other method can the pupil be led to so close and sympathetic an appreciation of land forms; in no other way can he gain so clear an understanding of the true nature of this important division of Physical Geography. But in order to hold the mind on the truly physiographic aspects of the subject attention should be primarily directed to the forms assumed at a given stage in the cycle of development, and only secondarily to the destructive processes by which the development is carried forward. See "The Rational Element in Geography," *National Geographic Magazine*, X, 1899, 466–473.

In adducing actual examples in illustration of typical forms, selection is made largely but not entirely from the United States. If all the examples mentioned are located

on a map of the United States, it will be found that a considerable part of our territory has been covered. It is important to note, however, that these examples are not introduced in order of location, as would be proper in a book on the physiography of the United States (a book on regional physiography), but in systematic order, following the scheme of classification adopted. This agrees with the method that is universally employed in the organic sciences; typical examples of plants and animals are there presented in systematic order, so as to emphasize the broad relations of the vegetable and animal kingdoms. It would be evidently inexpedient to begin the study of these subjects with examples taken in the arbitrary order of their distribution, or in the confused order of their association, over a country, however appropriate this order would be in the regional study of a flora or fauna after a satisfactory acquaintance with systematic botany or zoölogy had been gained; nor is it deemed advisable to attempt in an elementary book a combination of systematic and regional physiography — both subjects suffer in such a combination, for there is not space enough in a small book to do justice to them.

96, 97. Coastal plains are chosen as the simplest class of land forms, because their origin, structure, form, changes of form, and relations to adjoining areas can be so fully understood by beginners. The complicated subject of the forms of the land is thus entered upon in such a way as to lead the pupil to expect that he may understand all the rest of it. Nothing is here said of the process of elevation because so little is known of it (see p. 158). Note that the important conception of baselevel is first explicitly introduced on p. 145.

It is believed that the exercises in map drawing, suggested in the text (EPG, 144, 151, 155, etc.), will prove

useful in securing definite recognition of essential features by the pupil. The object of these exercises is not so much to teach the art of map drawing as to measure the thoroughness of the pupil's understanding of such illustrations as Fig. 62. In this respect these map exercises resemble the drawing exercises usually required in the study of botany and zoölogy.

98. The explanation and correlation of the different parts of the Atlantic coastal plain, as seen in South Carolina, may be taken in illustration of the value of the rational method in physiographic description. Instead of describing the succession of forms from the outer to the inner border of the plain in an empirical manner, they are described as the result of simple natural conditions of deposition, uplift, and erosion. There can be no question that the understanding of land forms thus gained increases the interest and aids the memory of the pupil. At the same time it is important here and elsewhere to give attention primarily to the facts of form, and only secondarily to the processes by which the forms have been produced.

99. No proper understanding of this kind of coastal plain can be gained without recognizing the succession of strata of which it is composed; but a sufficient preparation for the knowledge needed here has been made in Secs. 78, 96, 97. This knowledge is further applied in Sec. 103.

100. The evidence of depression of the land given by an embayed coastal plain should be contrasted with the evidence of elevation given in Secs. 97, 98; the results make proof of the statements made in Sec. 91.

102. A notable feature of extensive plains is their relatively uniform climate over large areas, in contrast to the rapid change of climate encountered in ascending mountains. See Sec. 114.

104. The vertical sections drawn across the front of Figs. 75, 76, 77 should suggest even to the beginner that the canyons there shown have not been made by fractures in the earth's crust, but are purely the work of the stream by which the channel has been worn down, and of the weather by which the canyon walls have been worn back so that the valley is widened. It was Mayor Powell's party that went down the Colorado river through the Grand canyon in northern Arizona. See reference, EPG, 380.

106. A profitable comparison may be made between the forms here described, in which the valleys have widened so far as to consume nearly all the plateau, and the forms described in Sec. 104, in which most of the plateau is still undissected.

107. The example here presented is important as a connecting link between Chaps. V and VI.

CHAPTER VI. — MOUNTAINS

108. In popular language the term *mountain* is applied to lofty land-forms of whatever origin, and therefore includes the great hills of dissected plateaus (Sec. 105), where the people often call themselves "mountaineers" (p. 170), and to the great cones of volcanic regions (Sec. 128), as well as to the forms described in this chapter. In more scientific usage the term *mountain* is coming to be restricted to forms of disordered structure in which the earth's crust has been significantly broken, tilted, or folded, and in which the uplifted parts are more or less eroded by streams and other destructive agencies. Chap. VI therefore stands between the preceding and following chapters, the first of which describes land forms of essentially horizontal strata (plains and plateaus), and the second of

which describes land forms that are built up by the eruption of lavas from some deep source through the earth's crust to the surface. This distinction of plateaus, mountains, and volcanoes is fully warranted by the many unlike features which are associated with the three classes of forms, as set forth in the three chapters referred to. The distinction is, moreover, one of the many indications of the more systematic treatment of land forms by which modern Physical Geography is so largely characterized.

109, 110. As with plains so here with mountains, the simplest examples of the class are described first. The block mountains of southern Oregon are more dissected than is indicated in Fig. 84. Although the forces by which the blocks have been broken and tilted are not yet understood, the forms of the tilted blocks are so simple that they can be easily apprehended. The forms described in Sec. 110 are a natural result of greater displacement and greater dissection than is described for the forms in Sec. 109.

111. An important exercise is furnished by comparing the different valleys and ravines shown in Fig. 87. The large longitudinal valleys are primarily the result of deformation rather than of erosion, although erosion has significantly modified the form of the side slopes; such valleys might well be called troughs. The cross valley, passing through the middle arch, is a true valley of erosion. So are the smaller ravines by which the flanks of the arched ridges are dissected.

112, 113. The structure of lofty mountains is so complicated that it cannot be profitably considered in an elementary book. Attention is therefore directed to their form and associated features.

118. It used to be believed that each peaked ridge of a lofty mountain range was a separately uplifted block of

the earth's crust, that the valleys between the ridges were the depressions between the uplifted blocks, and that erosion had done comparatively little work in carving the mountain forms. It is now abundantly proved that mountain ranges would, as a rule, have relatively broad and simple forms if they were the result of uplift without erosion, and that the wonderful variety of peak and pass, spur and valley, is the work of weather and water acting through long ages. The depth to which the valleys have been carved is a natural result of the great height to which the mountain masses have been uplifted. The great volume of rock waste that has been swept away by the streams which carved the valleys is often seen spread out in extensive plains bordering the mountains. See Secs. 152, 153.

The activity of the processes of erosion as a characteristic of lofty mountains deserves especial emphasis. The forms assumed by the waste that is washed down into the valleys deserve deliberate attention (EPG, 197–200).

120. The traditional association of volcanoes and earthquakes in a single chapter, and the absence of all mention of earthquakes in connection with mountain ranges, represents a past stage of earth science. It was once thought that all earthquakes were the result of volcanic action of one kind or another. It is now well proved that many and probably most earthquakes are independent of volcanoes, and are the result of fractures and displacements in the earth's crust, such as are associated with growing mountain ranges. Illustration of this relation of mountains and earthquakes has already been given on p. 180; it is now further emphasized.

121, 122. Contrast the conditions of human life here described with those mentioned in Sec. 102.

122, 123. These sections follow in systematic order after those in which the forms of lofty mountains are described. Compare Secs. 123 and 106. Subdued and worn-down mountains exhibit the power of erosion in fashioning the earth's surface even better than the deep canyons of young plateaus and the deep valleys of lofty mountains. The examples of peneplains here given prove the essential accomplishment of the work of the geographical cycle (see an article by the author on "The Peneplain," *American Geologist*, XXIII, 1899, 207–249). The valleys by which a peneplain may now be dissected prove that a new cycle has been introduced by a general uplift of the region considered. The explanatory description of the uplands and valleys of southern New England makes it very easy to apprehend the leading features of this region and to understand the distribution of its population (pp. 208, 209). Many additional details are given in the author's essay on southern New England (see References, EPG, 381). The example given in Sec. 124 is one of the best known of its kind (see Sec. 158, and articles by Willis and Hayes given in the References, EPG, 381).

125. Compare with Sec. 100. The time since depression and embayment is indicated by the height of cliffs cut into the headlands by waves, and by the area of deltas built in the bay heads by streams. Hence if a mountain region is spoken of as "recently depressed and embayed," it must be understood to have only low headland cliffs and small bay-head deltas. This is a good illustration of the manner in which statement of process gives understanding of form.

Most of the bays and harbors of the world are formed by the depression of a coastal region and the consequent partial submergence of its valleys; but some reëntrants of

the shore line are formed by the destructive attack of the sea on the coast (Sec. 181), and some by deep glacial scouring (Sec. 184). This is a good example of the greater meaning and interest given to physiographic facts when they are rationally explained instead of being only empirically described. The origin of most bays as "half-drowned valleys" is so simple, so easily illustrated, and so readily understood even by young pupils, that one wonders why such an explanation was so long delayed in making its way into elementary text-books.

CHAPTER VII. — VOLCANOES

127, 128. These sections are chiefly concerned with the building of volcanoes by volcanic action; later sections tell of the dissection of volcanoes by weather and water. It is important to realize that the building of a great volcano required many eruptions through thousands of years. The occasional reversal of volcanic eruptions from constructive to destructive action, as indicated by the formation of calderas, deserves emphasis. The alternation of these processes is well shown in the combination of Vesuvius with Monte Somma (Fig. 109). The interbedded layers of ice in the walls of the caldera of Deception island (p. 221) record a time when the cone had reached a certain size and was covered with snow and ice, as would be natural for a mountain in a far southern latitude; later eruptions then buried the ice in ashes and lava; part of the ice was undoubtedly melted, but lava is so poor a conductor of heat that some of the ice remains unmelted even to this day; the engulfment of the upper cone in the caldera was later than all the eruptions by which the cone had been built. Mt. Mazama, holding Crater lake in its caldera, was made a national park

in 1902; it is coming to be a popular resort for excursionists (see References for Reading; also Diller's "Geology of Crater Lake National Park," United States Geological Survey, 1902, containing many excellent illustrations, one showing "Mt. Mazama restored"). The following recent publications describe the eruptions of Mt. Pelée, Martinique, in 1902:

HEILPRIN, Mount Pelée and the Tragedy of Martinique, Lippincott, 1903.

KENNAN, The Tragedy of Pelée, Outlook Company, 1902.

RUSSELL, Volcanic Eruptions on Martinique and St. Vincent, National Geographic Magazine, XIII, 1902, 415–436. This article contains references to forty-nine others.

129. See notes on Sec. 120, above.

130. Although volcanoes in all stages of development are more common near or in the oceans than in continental interiors, it should be recognized that some active and many extinct volcanoes are known far inland. As to the obscure geological problem of the cause of volcanic eruptions, suffice it here to note that the explosion of gases may be a relatively superficial part of the process, and that the ascent of lavas from their deep source may be largely due to the forces which are elsewhere manifested in deforming the earth's crust in mountain ranges.

131. The topic here treated has usually received too little attention in text-books on Physical Geography. The fact that Iceland is mostly made of broad lava flows, and that high volcanic cones are relatively exceptional there, is worth noting.

132. This topic has also been too generally neglected, probably because the dissection of volcanoes is so much less conspicuous a process than their construction. Most great volcanoes are more or less dissected.

CHAPTER VIII. — RIVERS AND VALLEYS

The most general relations of rivers and valleys having been presented in Chap. IV, and many specific examples of river action and valley form having been given in Chaps. V to VII in connection with the development of land forms, — a topic from which rivers and valleys cannot possibly be separated, — the present chapter is devoted to certain additional problems whose earlier consideration would have caused too great delay.

134. This section may be well introduced by the record of local observations and by inferences as to the effects of various conditions of the ground. The reason that rain is desired before the cold weather begins is that ground water, springs and wells, may be well fed before their supply is cut off by the freezing of the ground.

136. The head of a stream does not reach to the head of the valley that it drains. Above the head of the stream the valley floor is not worn down to the level of ground water. The absence of streams on inter-valley uplands, such as those of Fig. 65, is explained in the same way; for the upland surface stands above the level of its ground water except at times of wet weather. The occurrence of fresh-water springs on ocean beaches illustrates the movement of ground water from the land toward the sea.

Like the surface of a stream, the surface of ground water must have a slope in order to cause movement; the stronger the slope, the faster the movement. Owing to the many obstructions that impede the flow of ground water, its surface slope is usually much steeper than that of the streams in a given district. When rain falls and enters the ground, the surface of the ground water is

temporarily raised, the slope of its surface toward its many points of discharge is increased, and the springs that it feeds have a more copious outflow. During a drought these conditions are all reversed — a long drought may cause the ground-water surface to sink beneath the level of certain springs and wells; the springs then dry up and the wells fail. See Sec. 142.

Avoid the implication too often made that springs occur only at stream sources because streams have their source in springs. Innumerable springs occur, usually unnoticed, in the banks and bed all along a stream course.

137. Various complications attending the supply of artesian wells are described in an essay by Chamberlin (see References, EPG, 382). A useful practical exercise is as follows: Draw a map of the coastal plain shown in Fig. 120. Indicate a scale of miles (the breadth of the plain from its inner border to the seashore may be taken as from ten to fifty or one hundred miles). Assume that the plain slopes toward the sea at the rate of from two to five feet per mile, and that the strata which underlie the plain slope at a rate of from five to fifty feet per mile. Now determine the depth to which a well must be bored at or near the shore line in order to penetrate either one of the water-bearing strata, or *aquifers.*

138, 139, 140. The exceptional features here treated are of much less importance in elementary study than those of common occurrence and easy observation, such as next follow.

141. Note that a river is here defined (p. 241) as "a stream of water bearing the rainfall *and the waste of the land* . . . to the sea." The local observations referred to at the end of this section may be made very instructive if the school district permits them.

143. This section affords opportunity of recalling statements concerning rivers and valleys in many earlier sections. See, for example, Secs. 94, 97, 104, 105, 106, 118, 123, 132.

144, 145, 146. Time as an element of the description of land forms has already been referred to (see notes, above, on Chaps. IV and V). Time is now found to be of equal service in the description of rivers, and in no other part of Physical Geography is the value of a rational treatment better illustrated. It is not merely for convenience that lakes and rapids are treated in connection with young rivers; it is because lakes and rapids are habitual features of such rivers. The association of the features treated in Secs. 144, 145, 146 therefore serves to impress something of the order of nature upon the pupil's mind, as well as to furnish him with appropriate information on certain topics.

Many features of young rivers are well illustrated upon the arched surface of a street or road just after a rain.

147, 148. The generalizations here presented are of much importance. They are treated in a more advanced manner in an article by the author on "Baselevel, Grade, and Peneplain," *Journal of Geology* (Chicago), X, 1902, 77–111. Note that when a river is first graded its valley may be deep, its side streams active, and its load of waste large; at such a time the slope of the river must be relatively strong, so as to produce a sufficient velocity to carry the large load (see p. 261). It is for this reason that rivers in mountain valleys have rapid flow. But as the cycle of erosion advances and the river basin is worn down to fainter and fainter relief, the river load becomes less in quantity and finer in texture, and an increasing share of land waste is carried in solution. With the progress of these changes

the river adopts a fainter and fainter slope, but maintains its graded condition all the while.

The gradual development of the graded condition by the successive obliteration of rapids, — those on the most resistant rocks remaining longest, — and the consequent merging of previously separated short reaches with continuous longer reaches, is a characteristic process in river history. Here as elsewhere it is important to note the orderly sequence in the development of the various features of a river system. The essential features of an actual stream may be concisely indicated by stating the stage that it has reached in its development.

149. It must be borne in mind, when the erosion and development of valleys is under discussion, that a river does not occupy the valley, but only a channel in the valley floor. A river receives and sweeps along its channel all the waste that is washed down from the valley sides, and in that indirect way a river may be said to have eroded its valley. As a matter of fact, the river deepens the valley by eroding the bed and banks of its channel; while the widening of the valley is accomplished chiefly by the action of the weather on the valley sides, and only to a less degree by the lateral cutting of the river. Inasmuch as most valleys are much wider than they are deep, — this being the case even in the Colorado canyon, — it follows that rivers and streams are chiefly active as transporting agents, and that the most important agents of erosion, as far as the volume of material eroded is concerned, are the processes of weathering and rain washing. The creeping of waste down the slopes of a valley side is well suggested in Fig. 127.

150. Note that no flood plain is formed until the active deepening of a valley is checked on the attainment of the

graded condition by the river; that is, on the entrance into the mature stage of river life. When the deepening of the valley has practically ceased, and lateral erosion on the outer bank of a curving stream goes on alone, deposition must take place on the inner bank for the following reason: the graded condition implies a balance between carrying power and load: a decrease of velocity would cause a decrease in carrying power and a deposition of part of the load; if the outer bank were cut away and no deposit were formed on the inner bank, the breadth of the stream would be increased and its velocity therefore decreased. But with decrease of velocity some of the load must be deposited in the path of the slowest current. The slowest current will be along the inside of the curve; hence some deposit must take place there. The supposition that erosion can take place on the outer bank without a compensating deposition taking place on the inner bank is therefore unreasonable.

The systematic development of flood-plain strips and scrolls as a valley floor is widened by the erosion of its sides and spurs, shown in Fig. 130, should be carefully taught. Particular care should be taken to see that the pupils gain definite ideas on this subject. Drawing maps to illustrate the progress of flood-plain development, as suggested in the text (pp. 260, 261), will be found very serviceable.

151. The Preliminary Maps issued by the Mississippi River Commission, edition of 1900, contain many excellent illustrations of river meanders and their changes. Fig. 133 is reduced from one of them. The following principles, illustrated in Fig. 133, may be established by study of the Mississippi maps or of actual meandering *rivers.*

In consequence of the erosion taking place on the outside of the curves, the curves increase in size and the meander belt (included between lines drawn tangent to the succession of curves) widens. The growth of the curves and the widening of the belt continues until a short cut (new channel adopted at time of flood overflow) or a cut-off occurs; then the meander belt locally collapses to small breadth, leaving the abandoned meander or oxbow lake outside of it. As a result the radius of the oxbow lakes is usually longer than the average radius of the river curves. The whole system of meanders gradually works its way down the valley, because there is more wearing on the down-valley than on the up-valley side of the stretches between the curves. It is in consequence of the last-stated principle that the spurs in Fig. 130 are worn away on their up-valley side, and that the flood plain is formed on their down-valley side.

152, 153. Rivers are as effective in filling depressions with land waste as they are in eroding valleys in elevated areas. See note above, on Sec. 118. The surface of the filled depression will slope at a gentle angle so that the river shall flow across it in an essentially graded condition. The Indo-Gangetic plain in northern India and the plain of the Po in northern Italy are large river-made plains. Parts of the Great plains east of the Rocky mountains are covered with river-borne and river-deposited waste. See p. 159.

154. Note that strong rivers may build deltas in the face of strong tides. The absence of deltas at the mouths of various rivers of our Atlantic coastal plain has been erroneously explained as the result of tidal scour; the proper explanation is that deltas are absent because the region has been depressed so recently, as the earth counts time, that the rivers have not yet had time to build deltas

even in the protected bay heads. See notes above, on Secs. 100, 125.

The fingerlike branches of the Mississippi delta are due to the great quantity of waste brought down by the huge river. As a rule, the front of a delta is trimmed to a smooth convex curve by the shore waves. See Sec. 185.

155, 156. Review of Sec. 144 should be made with these sections.

157. Examples of what are here called revived rivers have been given in Sec. 123. It is interesting to note that the Colorado in its Grand canyon (p. 165, 166) is a revived river; for there is good reason for believing that the broad plateau of northern Arizona is an uplifted and somewhat stripped and dissected peneplain.

158. The examples here described occur in the ridges shown in Fig. 103. There is a widespread misunderstanding regarding water gaps. It is commonly assumed that the lower lands, upstream and downstream from a gap, existed as lowlands before any notch was cut in the continuous ridge between them. The error here lies in the implication that only the gap and not the lowlands also require explanation. Note therefore that the lowlands as well as the gap have been worn down from about the level of the ridge crest (Fig. 141); that as the river began to cut down its new valley, no point upstream could be cut down quite as deep as a point farther downstream, for the river must preserve a sloping channel; but that the widening of the new valley at any point depends only on the nature of the local rocks. Where the rocks are resistant, the valley will long be held narrow; where they are weak, it may soon be widely opened by the rapid weathering of the valley sides. The example in Figs. 140, 141 shows a district in which the weak rock areas are so

rapidly worn away, compared to the belt of the resistant rock, that the latter still stands up as a strong ridge when the former are worn down to local peneplains.

CHAPTER IX. — DESERTS AND GLACIERS

The states lying south of the glaciated area (Fig. 151) and east of the arid region (Fig. 29) are fortunately situated, in that they offer local opportunity for the study of the effects of erosion under normal climatic conditions, as in the Ozark plateau (Sec. 159, Fig. 143) or in the Piedmont belt (Sec. 123). (See an article by the author on the "Stream Contest along the Blue Ridge," *Bulletin, Geographical Society of Philadelphia*, 1903.) The illustration of the effects of normal erosion by the study of local examples is more difficult in the glaciated region, for there one frequently encounters facts whose proper explanation cannot be found in the work of weather and water alone. It therefore requires some ingenuity on the part of the teacher whose school is situated in the arid or the glacial region to plan field excursions for the illustration of normal land forms. One of the most effective aids in planning such excursions is found in an understanding of the land forms that are due to the abnormal processes of erosion, as described in this chapter.

161. The ordinary definition of a river is not precisely applicable to the streams of arid regions, because of their intermittent flow. It is usually a surprise for persons who have grown up in the eastern United States to find how many stream beds are dry for a large part of the year in the western region of light rainfall. Many features of these dry channels are illustrated in miniature in roadside gullies during fair weather.

162. Small illustrations of bad lands are found in the gullied "old fields" of the Piedmont belt in the Southern States. The dissection of that belt was accomplished when the region was forest covered and when a large part of the rainfall sank into the ground, to reappear as springs in the well-spaced streams. The hill and spurs are of broadly rounded, full-bodied form. Now that the forests have been largely cleared away, the deep-weathered soil is no longer well protected from rain washing. The soil of neglected hillside fields is therefore often deeply scoured by rain gullies, imitating bad land forms of small area.

164. See "A Temporary Sahara," *Journal of School Geography*, IV, 1900, 171–175.

166. The reports and essays by Gilbert and Russell (cited in the References, p. 383) concerning the ancient lakes of the now desert basins of Utah and Nevada will be found to contain many quotable descriptions and illustrations of existing forms due to ancient lake action.

168–171. The most important general principle to be noted here concerns the slow motion of all these ice sheets and ice streams. They may therefore be considered in a certain way similar to water streams. But rivers are nimble and flow rapidly as slender streams in narrow, gently sloping channels, while glaciers are extremely sluggish and creep slowly in broad, clumsy streams on steep slopes. A river channel is but a small part of the valley that it drains; a glacier channel may be a large part of its drainage area. See Plate XIV.

The glaciers of Alaska and Greenland frequently enter the sea, like ordinary rivers; but the glaciers of most Alpine mountains melt away long before reaching the sea, as in Fig. 148. Such glaciers should be compared with the withering streams of desert mountains, as in Fig. 15.

172. Surfaces formerly occupied by ice sheets or glaciers may be compared with the beds of river channels in arid regions from which the water has temporarily dried away. The comparison just suggested between a glacier and a withering river may here be applied again: like the upper waters of such a river, the upper part of a glacier usually erodes its bed; like the lower waters of the river which spread their load of waste out upon the plain, where they dry away, the lower part of a glacier may be more of a depositing than an eroding agent.

174. One of the most noteworthy features of strongly glaciated mountain valleys, fully recognized only in the last few years, is the occurrence of hanging lateral valleys, which open in the side walls of the main valley, as in Fig. 156. Here the proper comparison with rivers is made as follows: What we now call a glaciated valley was the channel of an ancient glacier; it must therefore be compared not with a river valley but with a river channel. When a small tributary enters a large river, the channel of the tributary even at its mouth is not so deep as the channel of the main river. If the channels were laid bare and dry, we should see the bed of the tributary hanging above the bed of the main river. This is precisely the relation that obtains in strongly glaciated mountains, where the hanging lateral "valleys" join the main "valley." When they were occupied with ice streams, the *surface* of the lateral glacier joined the *surface* of the main glacier at even grade; but the *bed* of the main glacial channel was eroded much deeper than the *bed* of the lateral glacier. Lakes are often found in the most deeply eroded parts of such valleys. Similarly, pools are found in the beds of dried-up rivers. The sides of a glacial channel are worn comparatively even, like the banks of a river, when

the glacier has melted away, the trough-like channel, now called a valley, is peculiar in having cliff-like lower walls relatively free from strongly projecting spurs. A good example is shown in Plate XV. See Gannett on "Lake Chelan," *National Geographic Magazine*, IX, 1898, 418–428; and the author's essay on "Glacial Erosion in the Valley of the Ticino," *Appalachia*, IX, 1899, 136–156.

In a region broadly overridden by an ice sheet the whole surface must be compared to a broad river bed. In northeastern America the ancient ice sheet was usually destructive in the highlands of eastern Canada, but it was constructive, as a rule, in the states next south of the Great lakes, where it spread out a broad sheet of glacial waste. In both regions the streams of to-day are greatly disordered by the results of glacial action, and it is for this reason that those of eastern Canada were instanced in Sec. 144 as examples of young rivers. Elaborate accounts of the low moraines and the heavy drift sheets of the prairie states are to be found in essays by Leverett in recent reports and monographs of the United States Geological Survey. The relatively small progress of river development in these glaciated regions shows that the glacial period must have ended not long ago, as the earth measures time.

CHAPTER X. — SHORE LINES

Shore lines are treated in a manner similar to that thus far employed for river-carved land forms. A movement of the earth's crust places a land area in a certain attitude with respect to the surface of the ocean. The land lies passive, and is attacked by the forces of the sea. According to the amount of work thus done upon the land, its initial shore line is changed to a less or a greater degree;

the shore line may therefore be described as young, mature, or old. As in the cycle of the river-carved lands, the important principle to be recognized in the cycle of the sea-carved shores is the essentially systematic progress of the work, as a result of which the forms of the shore line are closely correlated with the passage of time. It is therefore possible here, as before, to describe the forms of the land in terms of the stage of the cycle that their development has reached.

As with rivers, the destructive action of the sea on the land is not made by water alone, but by the fragments of waste that the water carries.

178. Several features described in this and the following sections may be seen around the borders of ponds, or even of small wet-weather pools. It should be noted, however, that when the water in these pools sinks to a lower level or dries away, the shore lines should then be compared with those described in Sec. 166.

180. Note that the general progress of shore changes is here from initial irregularity towards mature simplicity. On the beaches of a simplified shore line the waves break evenly, as in Plate XVI.

183. Evidence of movements of the earth's crust, already found in Secs. 97, 100, 123, 125, 157, is here discovered in shore lines as well. The general statement of Sec. 91 is thus abundantly verified.

184. There has been much discussion as to the origin of fiords. They are regarded as of glacial origin by those who are convinced of the strong erosive power of heavy and (relatively) fast-moving glaciers (see Sec. 174 and notes on it, above). Not only so: heavy glaciers must erode their channels beneath the level of the sea, just as rivers do, but to a much greater degree. When the glaciers melt

away, the sea invades so much of the channel as has been worn below sea level. Hence the occurrence of fiords does not necessarily imply depression, as is the case with embayed mountains in non-glaciated regions (Sec. 125).

185. Compare with Sec. 154.

188, 189, 190. The theory that barrier reefs and atolls have been produced by a depression of the land on which a fringing reef originally grew has now been very generally replaced by the explanation here presented.

CHAPTER XI.—DISTRIBUTION OF PLANTS, ANIMALS, AND MAN

The history of life on the earth seems to have been a continual search for opportunity. Thus viewed, physiographic environment becomes of great interest and importance, for it is very largely in physiographic conditions that organic opportunity is found. These conditions are briefly reviewed in the present chapter, following in a general way the systematic order according to which physiographic elements have been already taken up, but giving a larger share of attention than before to organic consequences.

191. This is an introductory section to show in brief the nature of the problems that are taken up systematically in the following sections.

192, 193, 194. These sections make a simple statement of the fundamental problems of dispersal, balance of population, and variation.

195. The greatest contrasts with respect to conditions of living are afforded by the seas and the lands. Hence certain general characteristics of the occupants of the seas and the lands are here presented as organic responses to

these contrasted conditions. In this and the succeeding sections it is desired to show that living forms, both plant and animal, owe nearly all their peculiarities of structure to the physiographic controls in whose presence the peculiarities have been gradually developed. Organs of hearing and sight, for example, have been very slowly developed and improved from rudimentary beginnings as responses to the undulations by which sound and light are dispersed.

196, 197. The subdivision of the lands into continents has naturally had a great influence on the distribution of plant and animal forms, nowhere more important than in the development of the various races of mankind. It is worth noting that the study of races does not belong properly under Physical Geography, but under Descriptive or Political Geography. The subject is here introduced, not as a part of Physical Geography but as an illustration (with many others) of the enormous influence that the factors of Physical Geography have had on even the highest members of the earth's population. The last two paragraphs of Sec. 197 should be emphasized.

198. The distribution of life on islands is of special interest, for it was from some of the more striking illustrations thus afforded of the control of environment over organism that the modern doctrine of evolution received its earliest support.

199. The various climatic elements considered in this and in several following sections are of controlling importance in determining the distribution of plants and animals; but man's ingenuity enables him partly to overcome these controls in various ways, if it is worth his while to do so. Yet man also must submit to the larger climatic controls of polar cold and desert aridity.

203. The form of the lands naturally has its greatest effect where the element of vertical relief is most pronounced, that is, in mountains; and some illustrations of this element of control have been given in Secs. 115, 121, 122.

204, 205, 206. The control exerted by an arid climate is so important that three sections are devoted to it. Many of the most striking illustrations of the response of organisms to the physical conditions of their environment are found in deserts.

207–210. Many other examples might be suggested as supplements to those given here. It is desirable that the teacher should accumulate additional illustrations for these sections.

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